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VOLUME LXVII JUNE, 1957 NUMBER 6

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JUL 12 1957
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Books Received

Books and monographs received are acknowledged in this column. This notice may be regarded as a return courtesy to the publisher or author. Reviews will be published later as the editors may elect.

Notice of each book or monograph, including title, name of author, publisher, pagination, price etc., will be presented in these notices so that our readers may have all data at their disposal for further inquiry.

PRACTICAL OTOLARYNGOLOGY. By Gervais Ward McAuliffe, M.D., F.A.C.S., F.I.C.S., Associate Clinical Professor of Otolaryngology, Cornell University Medical College; Attending Otolaryngologist, New York Hospital; Diplomate, American Board of Otolaryngology; American Laryngological, Rhinological and Otological Society, American Board of Plastic Surgery, Harvey Society, Pan Pacific Surgical Association. 320 pages with Index. 16 plates and numerous other illustrations. New York: McGraw Hill Book Company, Inc. 330 West 42nd Street. 1957. Price $7.00.

MAGNETIC REMOVAL OF FOREIGN BODIES. By Murdock Equen, M.D., F.A.C.S., Founder and Chief of Staff, Ponce de Leon Infirmary, Atlanta, Ga. Recipient of the Thomas A. Edison Foundation Gold Award for Achievement and Contribution to the Arts and Sciences, 1944; Member of: American Laryngological Association, American Broncho-Esophagological Association; American Laryngological, Rhinological and Otological Society, Inc.; American Academy of Ophthalmology and Otolaryngology; Fulton County Medical Society; Southern Medical Association; American Medical Association; Fellow of the Southeastern Surgical Congress; Diplomate of the American Board of Otolaryngology. 94 pages with 119 illustrations. Springfield, Illinois: Chas. C. Thomas, Publishers, 301-327 East Lawrence Avenue. 1957. Price $4.50.

THE
LARYNGOSCOPE.

VOL. LXVII JUNE, 1957 No. 6

ENDAURAL MODIFIED RADICAL MASTOIDECTOMY.*

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Most of the cases of chronic otorrhea which we see today are suitable for some form of the modified radical mastoid operation. In my experience, the vast majority of cases come to surgery because of involvement of the antral and attic areas with cholesteatoma. In some 98 consecutive cases of chronic otorrhea treated surgically during the past ten years, 47 cases have required the endaural classical radical operation, whereas some 51 cases were treated by the endaural modified procedure.

In 1953, Baron[1a] reported 64 consecutive cases treated surgically for chronic otorrhea, in which the classical radical mastoidectomy was done on only 17; whereas 47 cases were suitable for the modified radical Bondy type. Baron[1b] also cited a series of 62 cases operated upon between 1938 and 1952 by Shambaugh and Derlacki, in which only 26 cases required the radical operation, while the modified radical was done on the remaining 36.

It is the purpose of this paper to review 50 consecutive cases treated by the endaural modified radical operation, and to report the results of the follow-up on these cases.

In 1953, before this same society, I reviewed the history of the modified or conservative mastoid operation, and reported

*Read at the meeting of the Eastern Section of the American Laryngological, Rhinological and Otological Society, Toronto, Canada, Jan. 31, 1957.

Editor's Note: This manuscript received in The Laryngoscope Office and accepted for publication March 18, 1957.

some 18 cases with follow-up studies.[2] Time will permit only a brief review of some of the historical facts related to this operation.

The modified or conservative radical mastoid operation has been associated in the past with such names as Jansen, Körner, Bárány, Heath, Bondy, Siebenmann, Ballenger, Richards and others. Then in 1938, Lempert[3] reported on his endaural approach to the temporal bone. The endaural approach, with its added advantages, revived interest in the surgical treatment of various diseases of the temporal bone.

Lempert,[3] Meltzer,[4] Shambaugh,[5] Woodruff and Henner,[6] House,[7] Maxwell,[8] Baron,[1b] Juers[9] and others have written on the endaural modified radical operation. In view of the above and as a result of my own experience, it is surprising to me that the usefulness of the various forms of the endaural modified radical operation have not been more widely taught and the procedure more generally adopted.

HEATH OPERATION.

The so-called "conservative mastoid operation" was first introduced in this country by Heath[10] in his article published in *The Lancet* in 1906. The title of his paper was "The Cure of Chronic Suppuration of the Middle Ear Without Removal of the Drum or the Ossicles, or the Loss of Hearing, with Ten Cases." Richards[11] gave a detailed description and modifications of the radical operation as done by Heath, Bondy[12] and Siebenmann.[13]

Heath, in his conservative mastoid operation, used the postauricular incision, but meticulously preserved the membranocutaneous canal wall for later use in cutting his original plastic meatal flap, which was somewhat similar to the Stacke plastic flap. Heath either left the lateral attic wall completely alone, or at least a part of it was allowed to remain for the insertion of the tympanic membrane. The ossicles were left intact. Heath used his conservative operation only in cases showing no evidence of cholesteatoma and where tympanic conditions indicated the possibility of repair. If

cholesteatoma was present, Heath elected to do the classical radical operation.

Some observers felt that Heath did his conservative operation in certain cases where the simple mastoidectomy might has sufficed and, therefore, they tended to discredit the procedure; nevertheless, Heath demonstrated one very important fact: That inflammatory changes in the middle ear were reversible, providing the patency of the Eustachian tube was respected and the tympanic cavity protected by exteriorizing the involved mastoid antrum by way of the external auditory canal.

In 1907, before the Chicago Medical Society, Ballenger[14] reported ten cases operated on by the Heath method with good results. He claimed (a) improved hearing; (b) frequent closure of perforations of the tympanic membrane within three to four weeks; (c) subsiding of the morbid process in the tympanic cavity, and (d) drainage of the antrum and mastoid cells into the auditory meatus, thus relieving the Eustachian tube of excess secretions. All cases showed improvement in hearing with curative results as good as with the radical operation. At this meeting, during the discussion, Dr. Beck[15] also reported several cases done with equally good results.

Today one sees few cases of chronic otorrhea where the disease, usually cholesteatoma, is limited to the mastoid antrum, and the hearing is quite good; however, such a case is suitable for the Heath procedure, and the operation should not be forgotten. Two such cases are reported in this series.

BONDY OPERATION.

The operation of Bondy, as reported by Richards, went further and included complete removal of the lateral attic wall. The ossicles were neither extracted nor disturbed in their relationship. The purpose of the operation was the protection of, and the conservation of the drum membrane and the ossicles. The bridge was thinned as far as possible without injury to the ossicles or tympanic membrane. If suppuration continued, due to involvement of the head of the malleus

or the body of the incus, these structures were removed later under local anesthesia.

Bondy felt that his procedure was indicated where the hearing for conversation was two meters or better, providing that it was possible that the ossicular chain was intact, and the middle ear cavity itself was not diseased, or but slightly. He felt that the operation was especially indicated where the perforation was limited to Shrapnell's membrane, the drum membrane intact and the hearing good, providing there was no material improvement after a conservative treatment of four weeks. Bondy included cases with cholesteatoma and felt this was not a contraindication, as the cholesteatoma was entirely removed.

SIEBENMANN OPERATION.

According to Richards, the Siebenmann operation differed from the classical radical operation, in that Siebenmann limited the scope of his operation to the removal of only so much of the bone of the mastoid region and attic area as was necessary to make all parts accessible through the external canal. The lateral attic wall, if touched, was only partly removed. The drum, malleus and incus were removed. The Eustachian tube was allowed to remain patent. An essential part of his operation was the "Y" type of incision for the meatal flap, which is known as the Siebenmann flap.

INDICATIONS.

In considering the modified radical operation, attention should be given to the following:

a. Condition of the pars tensa and the lower tympanic cavity.

b. Possibility of effecting a healthy-functioning lower tympanic cavity continuous with a patent Eustachian tube.

c. Degree of hearing loss in the affected ear.

d. Degree of hearing loss in the opposite ear.

e. Location of perforation or fistula.

f. Location and extent of bone destruction as shown by X-ray.

Attention to the above factors will contribute to the over-all objective of (a) elimination of pathology as well as infection, and (b) the preservation or restoration of hearing.

The above is not inconsistent with the primary objective, which is the patient's safety. The surgery must be adequate so as to insure this primary objective.

In considering the condition of the pars tensa and the lower tympanic cavity, it is not always essential that the pars tensa be intact (see Cases 38 and 45).

In order to eradicate disease completely and at the same time conserve hearing, one must find or create a healthy-functioning lower tympanic cavity, which is completely sealed off from the exteriorized cavity and is continuous with a patent healthy Eustachian tube; however, the best results are usually obtained when the pre-operative hearing is excellent, the pars tensa is intact and the lower tympanic cavity sealed off and healthy.

Good pre-operative hearing suggests an intact ossicular chain, or at least a mobile stapes with useful function in the lower tympanic cavity. If good hearing exists pre-operatively, then, with adequate surgery and reasonable post-operative care, the hearing should be retained.

The degree of hearing loss in the opposite ear is of obvious importance. If the hearing in the ear to be operated upon is poor, but still the better ear, we are apt to be more liberal in our requirements. Seven patients in this series had loss of useful hearing in the opposite ear.

The location of bone involvement and the location of the perforation are important. If the disease is confined to the mastoid antrum, one has an ideal condition to treat. If there is a posterior Shrapnell's perforation, and the disease is confined to the posterior compartment of the attic and mastoid antrum, one still has a good situation.

The anterior attic perforations with involvement of the

anterior compartment usually require more attention and precautions.

In practice, the commonest type of case suitable for the modified radical operation is one with cholesteatoma formation involving the mastoid antrum and usually the posterior attic compartment or the entire attic area. Occasionally, the disease is confined to the mastoid antrum and shows only a fistula through the inner posterior superior bony canal wall, or perhaps a very posterior Shrapnell's perforation (see Cases 4 and 6).

TECHNIQUE.

All cases were done by the endaural approach, using essentially the incision described by Lempert.[3] The tympanomeatal structures and the membranous canal wall were kept intact until the full extent of the pathology and the condition of the attic and middle ear structure could be determined. After a thorough evaluation of the findings, either the classical radical or the modified radical was done, depending upon the circumstances. If the modified radical was to be done, then, depending upon the findings, various modifications of the Lempert tympanomeatal flap were used; or, if the middle ear was completely sealed off, as it frequently was, the Shambaugh-type plastic canal flap was used.

Baron[1a] in 1954, in his article in THE LARYNGOSCOPE, gave several illustrations of his various modifications of the canal flap and of the tympanomeatal flap. These are quite useful; the important point is that the procedure must be suited to the individual pathology at hand.

Except for the occasional case suitable for the Heath modification, the entire lateral attic wall should be completely removed, and the facial ridge should be well taken down. In most cases essentially the Bondy procedure was used; however, the procedures were not confined to the Bondy technique. Usually, one or more small full-thickness free skin grafts were used at key points to line the cavity.

In cases with good hearing and an intact ossicular chain,

the ossicles were left where this was possible. In several cases (see Cases 1, 26, 31, 43 and 46), the incus was absent or removed because of disease, but the head of the malleus was left intact. In 21 cases, the incus and the head of the malleus were either diseased or surgically removed.

CHOLESTEATOMA MATRIX.

Forty-two of the 50 cases in this series showed cholesteatoma at the time of operation. For the most part, the cholesteatoma was entirely removed, except for that portion of the matrix which sealed off the tympanic cavity, and in some instances actually covered an intact incus and head of the malleus. In the cases with cholesteatoma, care was taken to have a well-formed cavity and to exteriorize completely any matrix which was left behind. In the cases with cholesteatoma matrix sealing over the tympanic cavity, observation revealed a thinning out of this matrix, until in time, it could not be distinguished from the adjoining epithelial lining or pars tensa. On the whole, these cavities heal more quickly and give little, if any more trouble, with post-operative care than the grafted cavities where every vestige of cholesteatoma has been removed.

One essential point in technique, I believe, is that the tympanic cavity must be closed. If cholesteatoma dips down into the tympanic cavity, it is better to remove the cholesteatoma completely, even at the expense of removal of the incus and the head of the malleus. Then the lower tympanic cavity is sealed by some tympanoplastic procedure, at the same time effecting contact between the head of the stapes and the pars tensa. This same principle applies to disease of the incus and head of the malleus. If they are diseased and are not removed, crusting or suppuration will probably continue, with eventual further impairment of hearing.

Success in this procedure is, to a great extent, dependent upon working with meticulous care and with vision, aided by magnification and good illumination.

PRESENTATION OF CASES.

In determining the hearing loss in the following cases, the average decibal loss for the three speech frequencies (512, 1024 and 2048) has been figured, as recommended by Carhart[16] and others.

For purposes of discussion, the 50 cases presented will be

Fig. 1. X-rays of mastoids (Law's position). Left—showing gross destruction (Case 4). Right—showing sclerosis with moderate destruction (Case 6).

divided into four groups, determined by the scope of surgery done:

a. The *first* group consisted of cases suitable for the Heath procedure (three cases).

b. In the *second* group were cases where the incus and head of the malleus were left intact (21 cases).

c. In the *third* group, the incus was removed, but the head of the malleus was left intact (five cases).

d. In the *fourth* group, the incus and head of the malleus were either absent or removed because of disease (21 cases).

GROUP 1.

Three cases, treated by the Heath procedure, resulted in the preservation or improvement of hearing, and in dry ears.

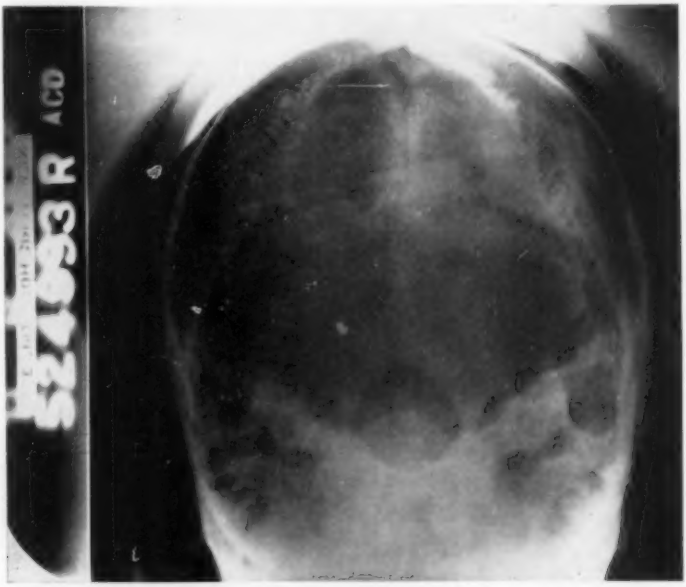

Fig. 2. X-rays of mastoids (fronto-occipital view). Left—marked periantral destruction (cholesteatoma) (Case 4). Right—moderate periantral destruction (cholesteatoma) (Case 6).

Case 4. Male, age 22, when first seen on Nov. 12, 1948, gave a history of left aural discharge for 12 years. A left simple mastoidectomy had failed to clear the ear. The patient complained of severe left temporal pain. Examination showed a large polyp filling the left external auditory canal and bathed in purulent exudate. Culture showed hemolytic staphylococcus aureus. X-rays showed marked destruction about the antrum and loss of tegmen antri (see Figs. 1 and 2).

Operation revealed a large cholesteatoma, involving the mastoid antrum and most of the mastoid cavity. Temporal dura was widely exposed by disease. There was a fistula of the posterior superior bony canal wall, through which the polyp emerged. The ossicles were intact and covered

by a cholesteatoma matrix. The pars tensa was intact. The Heath procedure was done. The aditus ad antrum was sealed. Hearing progressively improved from an average pre-operative level of 55 db. for the speech frequencies, to an average 12 db. for the speech frequencies post-operatively. The ear was dry in nine weeks; eight-year follow-up (see Fig. 3).

Case 6. Male, age 22, when first seen in November, 1948, gave a history of a discharging right ear for four to five years, and X-rays showed

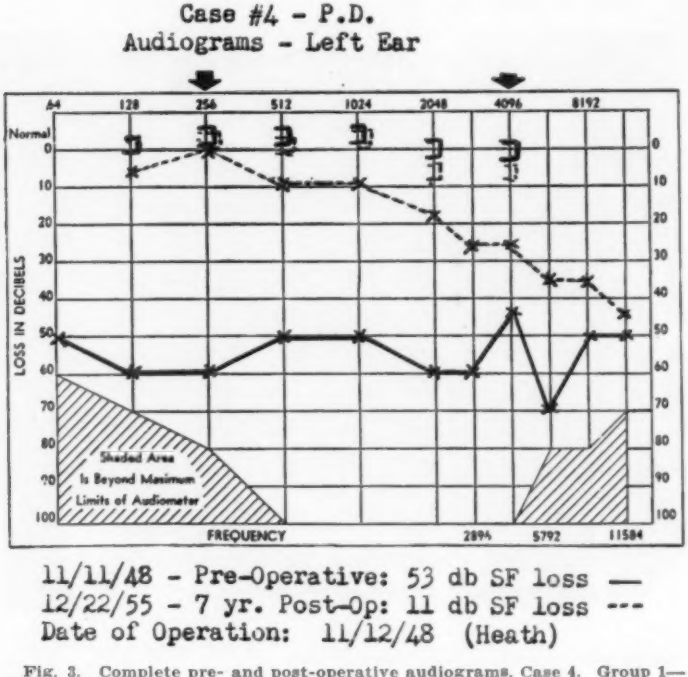

Fig. 3. Complete pre- and post-operative audiograms, Case 4. Group 1—ossicles intact.

destruction in the mastoid antrum area. Examination revealed a small posterior attic perforation and evidence of cholosteatoma. On Feb. 1, 1949, a Heath-type procedure was done, with removal of only the posterior aspect of the lateral attic wall; the bridge and ossicles were left intact. The pars tensa was intact, and the middle ear, including the anterior attic compartment, was sealed off by a cholesteatoma matrix. The ear was dry and epithelized completely in two months. Pre-operative hearing, an average 5 db. loss for the speech frequencies, was essentially unchanged with an average 3 db. loss eight years post-operatively (see Figs. 4 and 5).

Case 28. The third case in this group is interesting in that the Heath procedure was used to effect decompression of the facial nerve from the middle ear to the stylomastoid foramen. The anterior lateral attic wall and bridge were allowed to remain, and the aditis ad antrum was sealed off by means of a small full-thickness free graft of conchal skin. The function of the middle ear remained unchanged. Pre-operative hearing loss was an average 10 db. for the speech frequencies. On Dec. 28, 1956, approximately three years after operation, the hearing was essentially unchanged.

GROUP 2.

Group No. 2 is comprised of 21 cases in which conditions seemed to warrant retention of the incus and the head of the

Fig. 4. X-rays of mastoids (Law's position). Left—showing operative defect and surrounding healthy bone eight years after surgery (Case 4). Right—showing operative defect and surrounding healthy bone, eight years after surgery.

malleus. (Cases 3, 5, 7, 8, 9, 11, 16, 17, 18, 19, 22, 32, 33, 34, 36, 37, 39, 41, 42, 44 and 48). Fifteen of the 21 cases showed cholesteatoma at operation. All but six showed an intact pars tensa, and the middle ear sealed off by cholesteatoma matrix. Four patients in this group showed loss of useful hearing in the opposite ear. Satisfactory post-operative cavities were obtained in all but three cases. Two of these eventually obtained dry ears. One case, No. 34, required revision to obtain a dry ear.

Eleven of the 21 cases showed useful pre-operative hearing, with an average 21.1 db. loss for the speech frequencies. In

Fig. 5. X-rays of mastoids (fronto-occipital view). Left (Case 4). Right (Case 6). Showing operative defect and surrounding healthy bone eight years after surgery.

nine of the 11 patients with useful pre-operative hearing, the hearing level was either improved, or useful hearing maintained post-operatively, with an average 18.8 db. loss at the last audiogram. These nine patients were followed for from six months to over four years, with an average follow-up of about two years.

An additional four patients obtained useful hearing post-

operatively, where the average db. loss pre-operatively was greater than the 30 db. level. In these four cases the average db. loss pre-operatively was 36 db., and the average db. loss post-operatively was 23 db. (see Fig. 6).

The remaining six patients in Group 2 (Cases 9, 16, 17, 18, 19 and 39), showed on the average a 45 db. loss pre-operative-

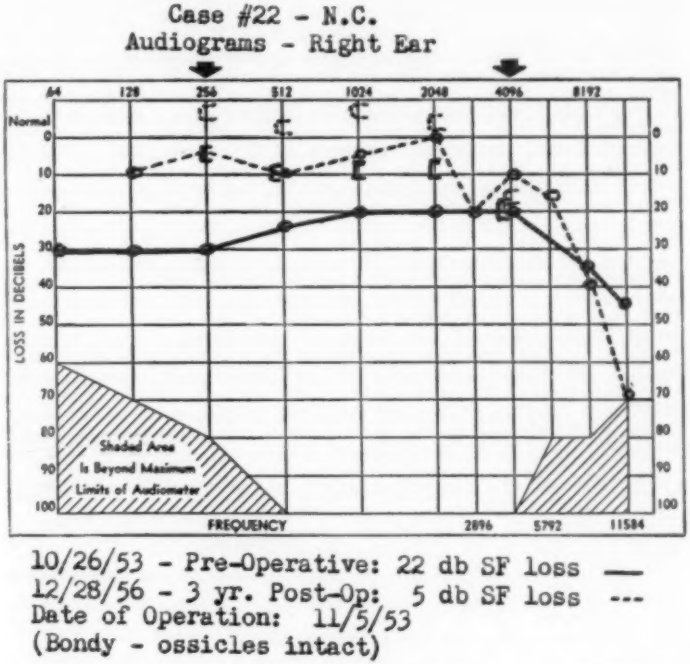

Fig. 6. Composite pre- and post-operative audiograms—Case 22, Group 2.

ly and on the average a 44 db. loss post-operatively. The average follow-up on these patients was four years.

Case 8. Male, age 53, when first seen in March, 1949, complained of intermittent discharge from each ear for the past 10 years. The patient had noted bilateral hearing impairment, more noticeable in the past several months, and more marked in his left ear. Examination showed bilateral posterior superior quadrant perforations and middle ear in-

volvement in each ear. There was more middle ear involvement in the left ear. There was an average 25 db. loss of hearing in the right ear and an average 38 db. loss in the left ear. X-rays showed bilateral sclerotic mastoids, with destruction in the area of the mastoid antrum on the right. A Bondy-type modified radical mastoidectomy was done on the right ear on March 8, 1949. The lateral attic wall was removed, but the incus and head of the malleus were left, with a narrow bridge. The covering matrix sealing off the middle ear was left. Post-operatively, the ear was dry, and the perforation closed in two months. Audiogram, done on Jan. 7, 1957, (patient is now age 61, almost eight years post-operatively) and showed an average 32 db. loss in the operated ear and a 52 db. average loss in the unoperated left ear. The patient was not wearing a hearing aid and didn't feel that he needed one.

Case 11. Female, age 37, complained of intermittent drainage from the left ear for 30 years, and intermittent pain and headache of the left temporal and mastoid area for the past ten years. The pain and headache had been more severe for the past several months. Examination showed a small posterior marginal attic perforation, and evidence of cholesteatoma. X-rays showed gross destruction in the mastoid antrum and attic areas. Audiogram showed a 25 db. average loss in the left ear and normal hearing in the right ear. At operation on Sept. 22, 1950, a large cholesteatoma was found, involving the antral and attic areas, with a large dural exposure in the mastoid tegmen area. The pars tensa was involved in its posterior superior quadrant, and the middle ear was incompletely sealed off. The Bondy-type procedure was done, with removal of the remaining lateral attic wall and bridge. The ossicles and cholesteatoma matrix over the ossicles and the middle ear were left; otherwise, the cholesteatoma was completely removed. The Shambaugh-type canal flap was used and a small full-thickness free skin graft inserted. Post-operatively, the cavity was epithelized in three months; however, crusting was a slight problem in the attic area for several months. Eventually the middle ear was sealed, and crusting ceased after about six months. Audiogram on Sept. 14, 1956, showed an average 42 db. loss. Failure to close off the lower middle ear at operation undoubtedly contributed to the delayed healing process, and the 17 db. average loss during six-year follow-up.

In Group 2, the complications found at operation included:

a. Large pathological dural exposure (Case 11).

b. Post-auricular fistula present for 35 years following a simple mastoidectomy (Case 17).

c. Fistula in the horizontal semicircular canal (Case 18).

GROUP 3.

All five patients in this group (Cases 1, 26, 31, 43 and 46) showed cholesteatoma, and in the five cases the incus was either destroyed by disease or removed at operation because of involvement. The head of the malleus was allowed to remain.

Case 1 warrants reporting separately, as it stresses two

errors in the surgical management, with resulting failure to obtain the desired objectives.

Case 1. Male patient, was first seen on April 25, 1947, complaining of constant discharge from his right ear of 17 years' duration. X-rays showed a sclerotic right mastoid, with considerable destruction of bone in the area of the mastoid antrum suggestive of cholesteatoma. Local examination showed a small posterior attic perforation, as well as a posterior superior quadrant perforation. At operation the incus showed

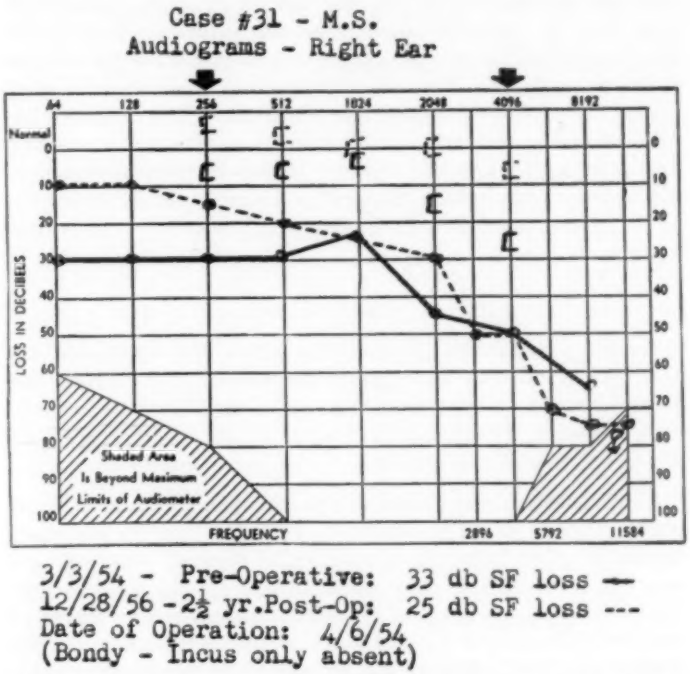

Fig. 7. Composite pre- and post-operative audiograms—Case 31, Group 3.

considerable necrosis, and the head of the malleus showed granulations. The lateral wall of the attic and the incus were removed. The head of the malleus was allowed to remain and the attic area left open. The middle ear was not sealed off. The pre-operative audiogram (April 25, 1947) showed an average 33 db. loss. The post-operative audiogram (Jan. 28, 1948) showed an improvement in hearing to an average 20 db. loss; however, the cavity required three months to epithelize, and attic crusting continued.

Audiogram five-and-a-half years post-operatively (Dec. 8, 1952) showed that the hearing had dropped to an average 43 db. loss. Obviously this patient had a mobile stapes, and had the diseased head of the malleus been removed and the middle ear sealed off, in all probability the patient would have retained his useful hearing, obtained a dry ear, and had a cavity requiring minimal post-operative care.

Cases 26, 31, 43 and 46 all showed an intact pars tensa and the lower middle ear sealed off by cholesteatoma matrix. Cases 31, 43 and 46 showed useful hearing post-operatively, with an average 25 db., 30 db. and 15 db. loss, respectively (see Fig. 7). Case 26 showed hearing improved from a pre-operative average 52 db. loss to a post-operative 38 db. loss three years later. The above four cases presented no post-operative problems, except for Case 26. This patient has had recurring catarrhal otitis media, secondary to chronic nasopharyngitis and salpingitis. He has no useful hearing in his opposite ear, which required a radical mastoidectomy in 1948. (Average follow-up of this group was three-and-a-half years).

GROUP 4.

Group 4 comprises 21 cases in which the incus and the head of the malleus were either destroyed by disease or else were removed at operation because of involvment of one or both (Cases 2, 10, 12, 13, 14, 15, 20, 21, 23, 24, 25, 27, 29, 30, 35, 38, 40, 45, 47, 49 and 50).

Cholesteatoma was found at operation in all cases. There was a history of aural discharge of from four to 30 years' duration. The pars tensa frequently showed scarring, but was intact in all but four cases (Cases 20, 24, 38 and 49). The incus and the head of the malleus were either partly or completely destroyed by disease in 18 of the 21 cases. In the remaining three cases, it was necessary to remove the incus and the head of the malleus to eliminate granulations and infection. Dry ears were obtained in all cases. The ears were dry and the cavities epithelized in an average of ten weeks. The middle ear was sealed off by cholesteatoma matrix in all but four cases (Cases 10, 30, 47 and 49).

Five patients in Group 4 showed hearing at or above the average 30 db. level in the operated ear, with a combined

average loss of 21.3 dbs. pre-operatively (Cases 10, 21, 38, 40 and 45). In four of these, the useful hearing was maintained post-operatively, with a combined average loss of 19 dbs. (see Fig. 8). The follow-up on these cases was from one to three-and-a-half years.

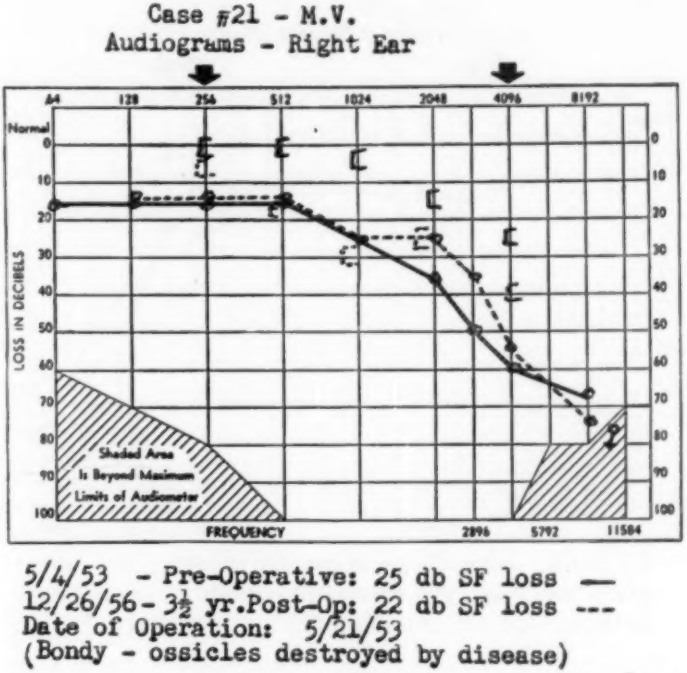

Fig. 8. Composite pre- and post-operative audiograms—Case 21, Group 4.

In two of these cases (38 and 45) the capitulum of the stapes was observed to be in contact with the pars tensa. This columellar effect, in association with a mobile stapes, undoubtedly accounted for the unusually good hearing in these two cases, as is noted in the pre-operative and post-operative audiograms (see Figs. 9 and 10).

In the remaining case (No. 10) there was a drop in hearing from an average 22 db. loss to an average 40 db. loss after four-and-a-half years. In this case, there was a large anterior attic perforation involving the anterior superior quadrant of the pars tensa. Although a dry ear was obtained

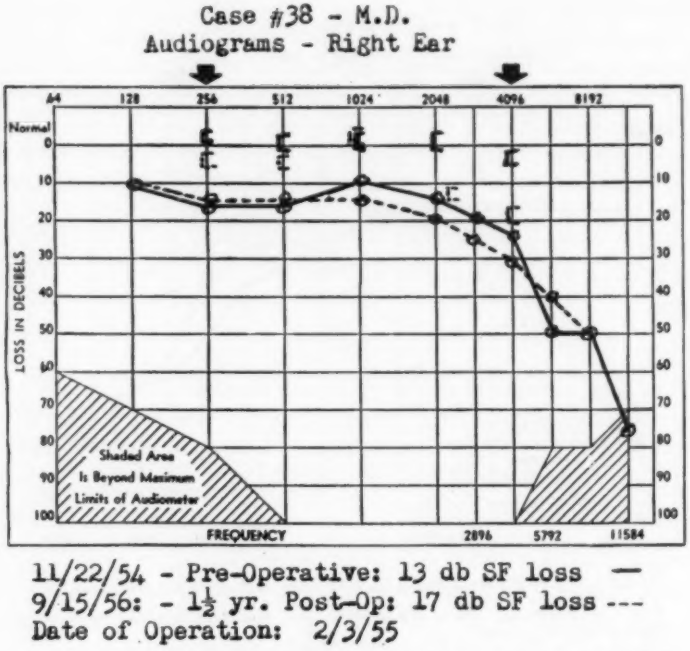

Fig. 9. Composite pre- and post-operative audiograms—Case 38, Group 4. Pars tensa in contact with capitulum.

and the hearing improved to an average 27 db. loss six month post-operatively (Nov. 6, 1950), this perforation remained open during the six-and-a-half years follow-up, and undoubtedly accounted for the progressive drop in hearing. Had the middle ear been sealed off at operation by a plastic canal flap or graft, there is a good possibility that useful hearing level would have been maintained.

Two additional cases (20 and 24) with an average 35 db., and an average 33 db. loss, respectively, prior to operation, showed useful hearing levels post-operatively. Four years post-operatively, Case 20 showed an average 17 db. improvement with a residual average of only 18 db. loss. Case 24

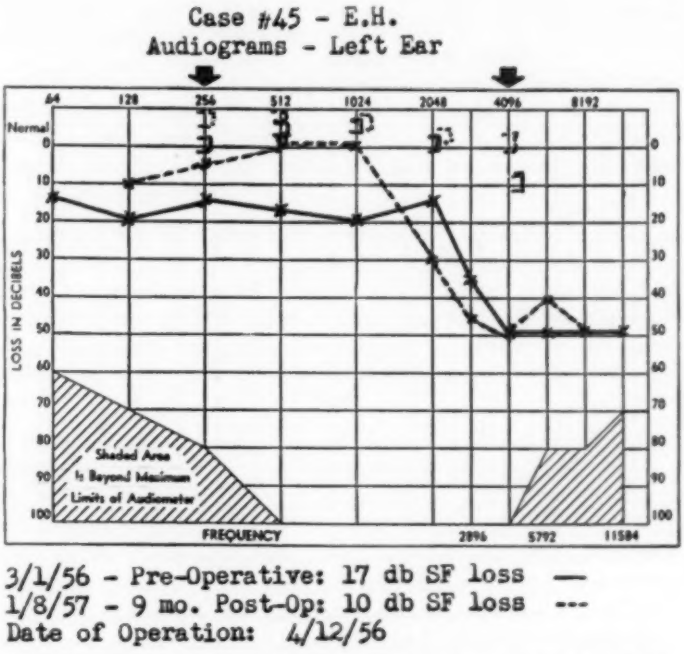

Fig. 10. Composite pre- and post-operative audiograms—Case 45, Group 4. Pars tensa in contact with capitulum.

showed a slight improvement to a residual average of 30 db. loss in a three-year follow-up.

The remaining 14 cases in Group 4 showed more severe hearing loss and could have been considered as suitable for the radical operation (Cases 2, 12, 13, 14, 15, 23, 25, 27, 29, 30, 35, 47, 49 and 50). These 14 patients showed the average of a 46.5 db. loss prior to operation. Following operation,

on the average there was a 51.9 db. loss, a net loss of about 5 dbs.

Case 2 showed improvement to the useful hearing level. The pre-operative hearing showed a 45 db. average loss. The five-year follow-up audiogram showed a residual of only 23 db. average loss (see Fig. 11).

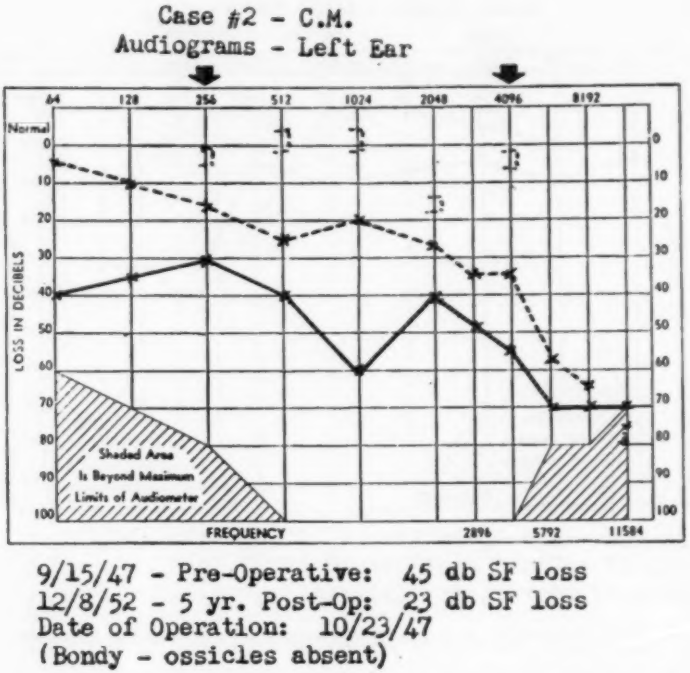

Fig. 11. Composite pre- and post-operative audiograms—Case 2, Group 4.

In Group 4, complications noted at operation included the following:

a. 2 cases with fistula in the horizontal semicircular canal.

b. 2 cases with dural exposure, secondary to disease.

c. 1 case with facial nerve exposed by disease.

SUMMARY.

Fifty cases of modified radical mastoidectomy, operated by the endaural technique, are presented. In 43 of these, cholesteatoma was noted at operation. In all but one case, there was a long history of otorrhea. The average duration of aural drainage was 15 years.

In Group 1, the two cases with extensive disease (cholesteatoma) operated by the Heath modification, show clean dry cavities after eight years, and with an average 12 db. residual hearing loss in one ear, and a residual average of 3 db. loss in the other ear.

In Group 2, 21 cases were treated by the Bondy modification, leaving the incus and the head of the malleus *in situ.* Dry ears were obtained in 19 of the 21 cases. One case, No. 34, required revision after six months to obtain a dry ear. Useful hearing was maintained at, or improved to, or above the average 30 db. level in 13 of the 21 cases, or about 66 per cent.

In Group 3, five cases were treated by the Bondy modification, in which the incus was either destroyed by disease or removed at operation, but the head of the malleus was allowed to remain. Three of the five cases obtained dry ears and useful hearing. One case, No. 26, obtained improved hearing, but not to the average 30 db. level. The remaining case, No. 1, never obtained a dry ear, and obtained only temporary hearing improvement because of faulty technique.

In Group 4, 21 cases were treated by the Bondy modification, where the incus and head of the malleus were either missing or removed at operation. Dry ears were obtained in 20 of the 21 cases. Useful hearing levels were obtained in six of the 21 cases (29 per cent). In one case, No. 10, failure to maintain useful hearing was the result of failure to seal off the lower tympanic cavity.

There were no complications in the post-operative follow-up which could be attributed to the utilization of the cholestea-

toma matrix where it was found to be sealing off the middle ear.

CONCLUSIONS.

The presence of cholesteatoma is not, in itself, a contra-indication for the modified radical operation.

The choice as to radical or modified radical operation should be made only at the operating table, after careful inspection and study of the antral, attic and tympanic areas. This inspection should be made with the eye aided by magnification and good illumination, as well as under good surgical exposure.

By proper judgment and good technique, one can obtain dry safe ears as well as good useful hearing in many selected cases.

Our objectives should include not only the safety of the patient, but also the conservation of hearing wherever this is possible.

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INSTITUTO MEXICANO DE LA AUDICION Y EL LENGUAJE.

The Mexican Institute of Hearing and Speech will offer an inter-American training course in Spanish for teachers of the deaf February 1 to December 31, 1958. Registration for the 1958 course closes October 31, 1957. This course will be held annually and will be under the auspices of Dr. S. Richard Silverman of Central Institute for the Deaf, St. Louis, Mo.

For further information write Professor Dr. Pedro Berruecos Tellez, 141-a Progress Street, Mexico 18, D.F.

TRANSANTRAL ORBITAL DECOMPRESSION FOR MALIGNANT EXOPHTHALMOS.*†

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Malignant or thyrotopic exophthalmos may occasionally progress to such an extreme degree that vision becomes seriously impaired. Under such circumstances some emergency operation is usually performed. Such measures, however, should be immediately effective in reversing the progressive nature of the disease.

During the past several decades many otolaryngological methods[1-15] have been proposed, but they have never been popular. There have been only single case reports and no long term follow-up studies. In this paper the authors will describe the operative technique used in seven patients in whom observations have been made up to ten years following surgery.

REVIEW OF THE LITERATURE.

All of the reported effective decompression procedures on the eye have been directed at either the roof, the medial or lateral wall or the floor of the orbit. Earlier, other approaches on the eye such as tarsorrhaphy,[16] canthotomy or removal of the orbital fat have offered little relief.[17,18,19] Similarly, removal of the greater cervical sympathetics has had no effect on the progress of the exophthalmos.[20-23]

Removal of Roof or Orbit: Naffziger[24-27] has written extensively on the subject, over the past 25 years, and his method

*Presented at the meeting of the Middle Section, American Laryngological, Rhinological and Otological Society, Inc., Cleveland, Ohio, Jan. 9, 1957.

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Editor's Note: This manuscript received in The Laryngoscope Office and accepted for publication Mar. 12, 1957.

is the most popular procedure used at the present time. In his technique (see Fig. 1) the head is shaved and a coronal or Souttar scalp incision is made. A frontal bone flap is turned with a hinge on the temporal fossa. The orbital plate is removed as widely as possible, limited by the frontal sinuses anteriorly and by the ethmoids medially. The posterolateral wall of the orbit is removed up to the orbital rim after retraction of the temporal muscle. The pterion and

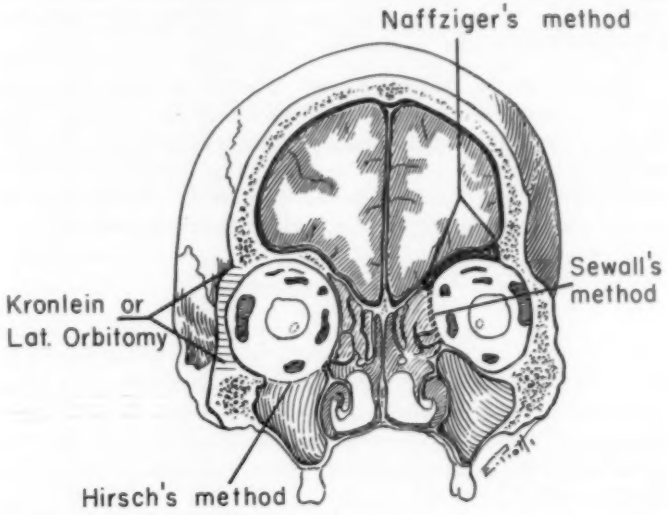

Fig. 1. (Revised from Hirsch). Surgical approaches to the orbit in malignant exophthalmos.

sphenoidal ridge are removed. In his experience, it has been unnecessary to unroof the optic foramen and incise the annulus of Zinn. The periorbita is opened wide.

Complications occurred in four of 31 reported cases. Rhinorrhea occurred in three patients and pneumococcal meningitis in one. In some instances it was noted that cerebral pulsations were transmitted to the eye. Poppen,[28] using Naffziger's method, operated upon 28 patients with good results in all except two.

Removal of the Lateral Wall: The Kronlein operation, or the lateral orbitomy approach[4,5,6,7] (see Fig. 1) was the first method used over 60 years ago; today it has very few followers. Swift,[8] McCravey and Mather,[9] Thomas and Woods,[10] and Anderson[11] have all reported on one case or more with some good and partially satisfactory results.

Removal of the Medial Orbital Wall: In this method, first described by Sewall[12] (see Fig. 1), the ethmoid plate is removed through an external route. Kistner,[13] Schall and Reagen[14] performed two operations, and Boyden[15] reported a satisfactory result in another instance.

Removal of the Orbital Floor: Hirsch[1] in 1929, (see Fig. 1) decompressed the orbit by removing the orbital floor through the canine fossa approach in one patient and subsequently wrote a resume on the same subject in 1950;[2] however, no additional cases were reported. Meesmann[3] removed the entire floor of the orbit in another patient.

SURGICAL INDICATIONS.

The history and findings in every case follow a classical pattern. Thyroidectomy is performed on a patient with exophthalmic goiter who presents the usual elevated basal metabolic rate and cardiovascular and nervous system manifestations. Clinical improvement follows except that exophthalmos does not disappear. In a variable period, sometimes in three or four months, it becomes evident that the proptosis is increasing. The decision for surgery in nearly all of these patients, however, remains to a great extent with the ophthalmologist.

There is increased fullness of the lids; then lacrimation and epiphora appear. The scleral conjunctiva appears watery and is followed by edema near the inner canthus followed by protrusion of the inferior palpebral mucosa. Diplopia and lack of parallelism of the eyes are followed by increasing limitation of the movements of the globe, and ultimately only downward movements are retained. The lids are unable to cover the globe, and the cornea becomes exposed. Episodes of corneal ulceration occur, and there is always danger

of panophthalmitis and perforation of the globe. With increasing proptosis, there is edema of the upper and lower lids, varying degrees of retinal hemorrhage, papillitis and rapid loss of vision. Under such circumstances immediate operative intervention becomes mandatory.

OBJECTIVES OF THE OPERATION.

1. To restore the vision that has been threatened, the use of the extraoccular muscles and the ability to close both eyelids.

2. To relieve increased orbital tension by allowing periorbital tissue to herniate into an actual space.

3. To attain a satisfactory cosmetic result.

4. To avoid unnecessary incisions on the face or scalp.

5. To avoid surgical trauma to an already injured eye.

6. To avoid serious immediate or late post-operative complications.

SURGICAL TECHNIQUE.

Pathological observations made in malignant exophthalmos show that there is increased intraorbital tension due to the enormous increase of fluid in the retro-orbital tissues as well as in the lids and conjunctiva.[24,26,27] Enlargement of the extraoccular muscles of from three to eight times the normal size with varying degrees of degeneration, fibrosis and inflammation has been noted by Naffziger.

In our method for the relief of orbital tension, the floor and the medial wall of the orbit are removed after the ethmoid air cells have been exenterated. The technique is essentially that described by DeLima.[29] The orbital periosteum is then incised allowing the orbital fat to herniate into the maxillary sinus and into the space created by removal of the ethmoid cells.

ANESTHESIA.

Intranasal topical anesthesia consists of the use of cocaine to the anterior ethmoidal nerves and sphenopalatine ganglion.

Local anesthesia (novacaine or xylocaine) is used for the posterior palatine canal and the transmandibular notch approach for blocking the maxillary division of the Vth nerve.

The usual buccogingival incision is made, and the anterior wall of the maxillary sinus is opened. The anterior opening created in the maxilla should be particularly large at its superomedial angle.

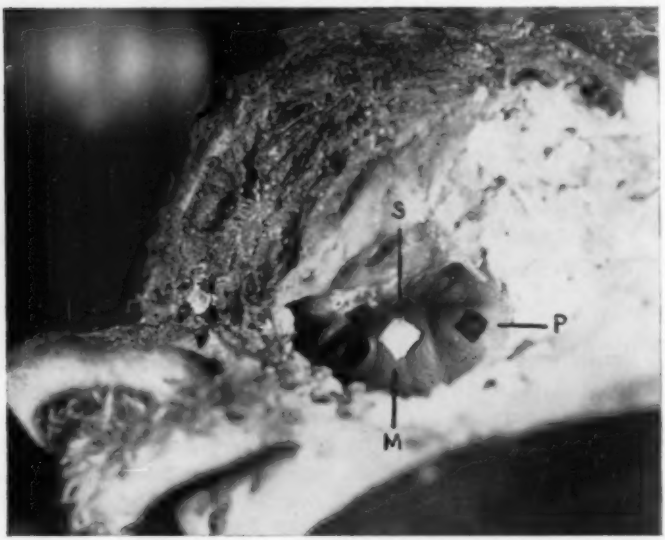

Fig. 2-A. For purposes of illustration in this cadaver the zygoma and the orbital rim has been removed. The black square indicates the junction point of the superior medial (M) and posterior (P) wall of the left maxillary sinus. The white square indicates the point of entry into the ethmoid labyrinth. M.—medial wall; S.—superior wall; P.—posterior wall.

For entry into the ethmoid cells the following landmark is used. From the point at which the superior, posterior and medial walls of the maxillary sinus come together, an imaginary line is drawn anteriorly along the junction of the superior and medial walls to the extreme point where the superior, medial and anterior wall join. At the midpoint along this line (see Figs. 2-A, 2-B) entrance into the ethmoid-

al cells is made with a forward biting forceps. The ethmoidal cells are opened until the point of junction of the superior, medial and posterior wall, previously noted, is reached, and have a transverse bony elevation, under which run the second division of the Vth nerve and the terminal branch of the internal maxillary artery, is noted. It is continuous with the posterior wall of the maxillary sinus and will be recog-

Fig. 2-B. Anterior ethmoid cells have been removed. I—Infraorbital vessel.

nized as a hard short transverse ridge on the medial aspect of the posterior wall of the maxillary sinus (see Fig. 3).

A bony ridge obstructs further exposure of the remaining ethmoid cells. This ridge must be removed with a chisel or a long handled mastoid curette until it is flush with the orbital plate thus permitting complete exposure of the whole ethmoid labyrinth (see Fig. 4-A, 4-B). With the bony canal wall housing as one landmark inferiorly and the flat orbital wall (lamina papyracea) as another, the posterior ethmoidal

cells are removed as far as the anterior face of the sphenoid. In removing the ethmoids, constant attention should be paid to staying inferior and against the lamina papyracea until the sphenoid is reached.

The further the head is extended the more vertical becomes the cribriform plate and the anterior cranial fossa, and the

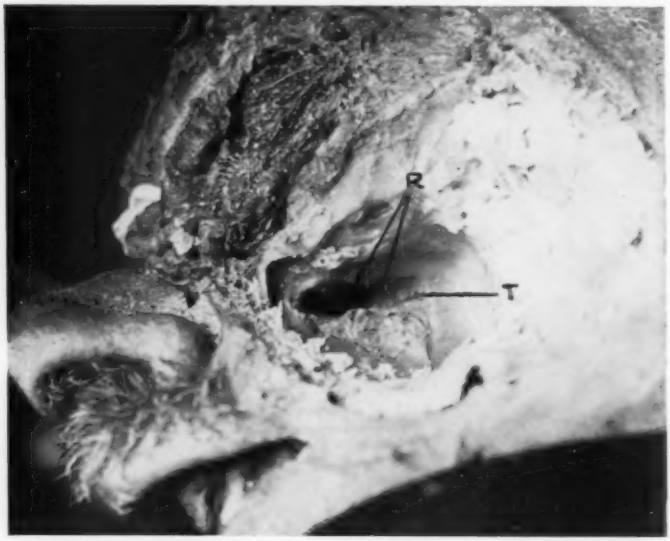

Fig. 3. Ridge of Bone (R) has been removed flush with orbital plate at junction of medial wall and floor of orbit posteriorly to transverse housing (T).

greater the risk of perforating the cribriform plate as one removes the ethmoid cells posteriorly. To avoid such an accident it is important to keep in mind constantly, first, the distance between the anterior nasal spine and the front face of the sphenoid and second, the position of the head.

With Kerrison bone rongeurs the floor of the orbit including the bony canal of the infraorbital nerve is removed, as far as possible posteriorly, to the zygoma laterally, and to the orbital rim anteriorly (see Fig. 5). The orbital peri-

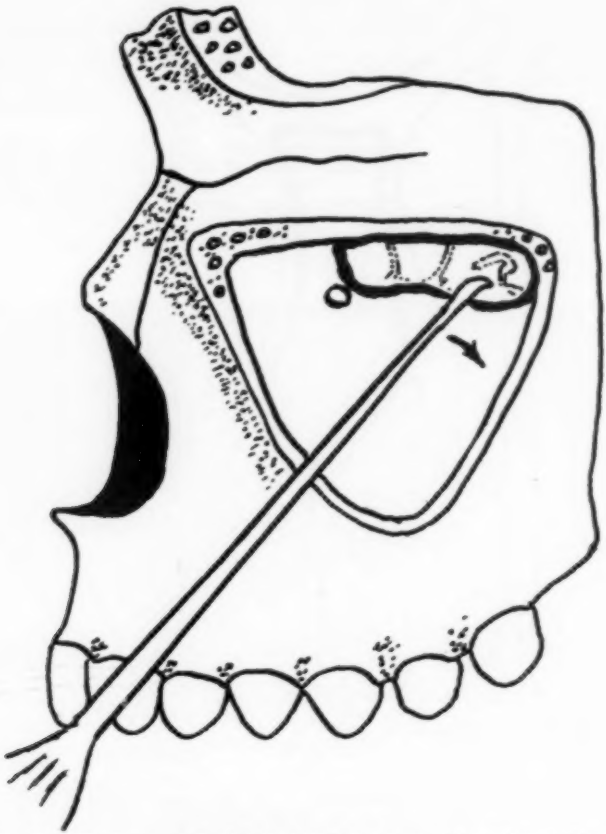

Fig. 4-A. Diagrammatic sketch showing exenteration of anterior ethmoidal cells.

osteum will be noted to bulge and frequently the infraorbital nerve to stretch, due to the orbital tension. The lamina papyracea is next removed to the anterior face of the sphenoid by fracturing this plate medially with the Freer elevator (see Figs. 6-A, 6-B).

Several postero-anterior incisions are made through the periosteum, and periorbital fat will be noted to herniate into

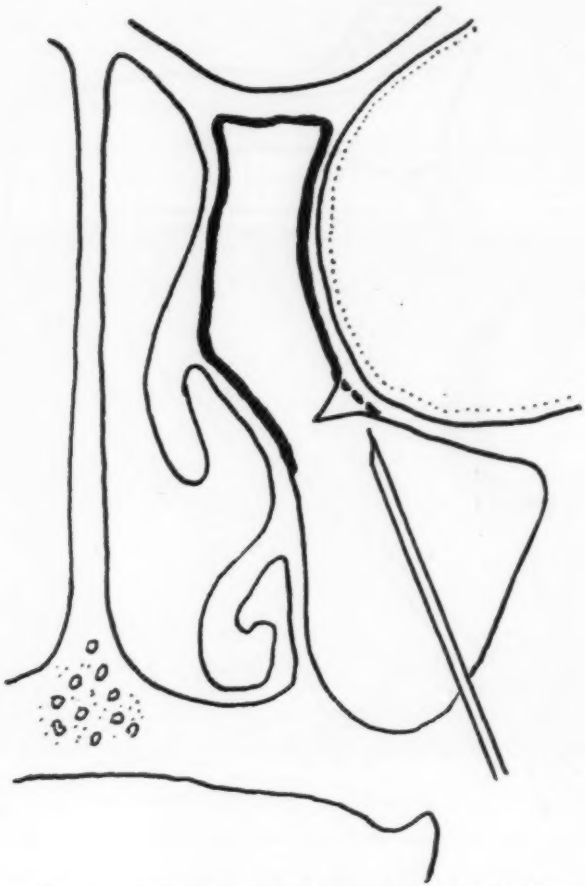

Fig. 4-B. Removal of ridge of bone against orbital plate.

the maxillary and ethmoid sinuses. Immediate dramatic decompression of the eye will be noted on incising the periosteum (see Figs. 7-A, 7-B).

A large nasoantral window is placed in the inferior meatus, and the buccogingival incision is closed.

Postoperatively little care is necessary other than one irrigation on the fifth day to remove any old blood that remains in the maxillary sinus. Antibiotics are usually not necessary.

Case 1. V.P., 39, w.f., was first admitted to Barnes Hospital on August 26, 1946, with a ten months' history of nervousness, weight loss, dyspnea and ankle edema. On December 8, 1945, she had had a subtotal thyroidectomy at the Missouri Pacific Hospital. Shortly after this the patient noted protrusion of her eyes and difficulty in moving her eyes, and progressive loss in vision. She was scheduled to have a Naffziger

Fig. 5. Floor of orbit has been removed including bony canal for infraorbital vein and vessels (outlined in dotted ink).

operation; however, before surgery, the anterior chamber of the left eye perforated with complete loss of vision in that eye. Since nothing could be done for the left eye a Naffziger operation was performed on the right side on April 11, 1956. There was little benefit noted by the neurosurgeon (Dr. L. Furlow) at that time.

She was readmitted to Barnes Hospital in August, 1946, with a marked degree of exophthalmos associated with marked edema of the eyelids. The conjunctiva was infected and edematous with small punctuate ulcers. Nearly complete ophthalmoplegia involving III, IV and VI nerves was present. The BMR was minus 19.

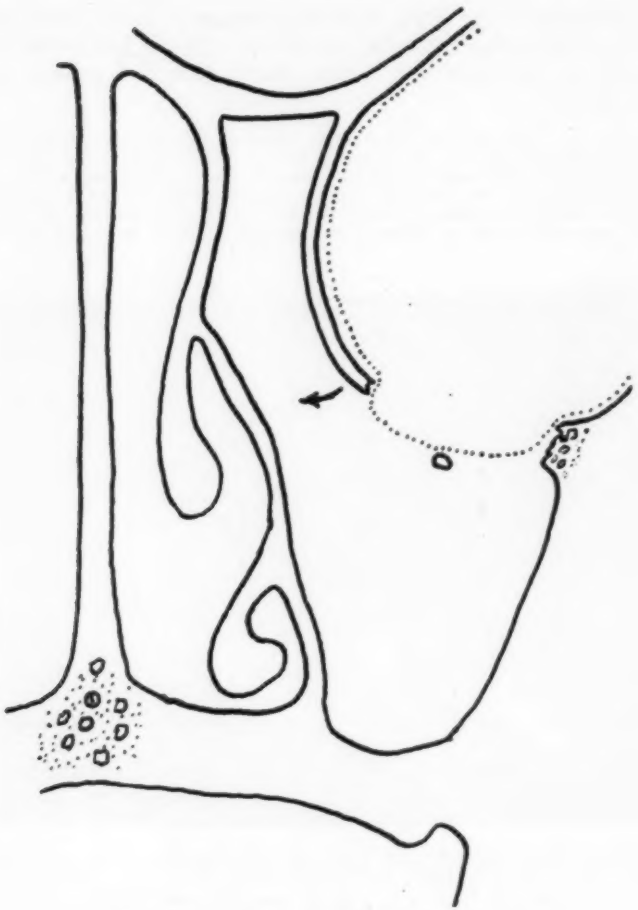

Fig. 6-A. Removal of medial wall of orbit.

An emergency tarsorrhaphy was done by the eye service (Dr. Reeh), and on August 31, 1946, a lateral orbital decompression was performed (Dr. F. McDowell). Only slight improvement resulted. She could still see only two fingers at three feet following surgery. On September 8, 1946, a transantral orbital decompression was done (see Figs. 8-A, 8-B).

There was marked immediate recession noted on the operating table.

Postoperatively, in order to inactivate the pituitary, she received X-ray therapy (1000 V through four portals, 12 treatments). She subsequently had her left eye removed in February, 1947.

Her vision in April, 1947, was 20/120. A year later vision of the OD with glasses was 20/70 with pinhole 20/50+3.

Over the past eight years the patient has had occasional colds, but at no time was there any orbital complications, and her vision has remained unchanged.

Case 2. G.W., 46, c.m., was admitted for the second time on September 15, 1947, with a diagnosis of malignant exophthalmos, toxic diffuse

Fig. 6-B. Ethmoid plate is removed.

goiter, syphilitic aortitis and aortic regurgitation, and a history of poorly treated syphilis. The patient noted the eyes to bulge in October, 1946. Treatment consisted of propyluracil. There was progression of the exophthalmos with the development of diplopia four months before surgery.

The BMR was 0. Examination revealed a soft asymetrically enlarged thyroid gland, a water hammer pulse, a harsh grade II systolic murmur at the aortic area and a diastolic blow along the left sternum.

The eyelids remained open even in sleep. The conjunctiva was injected and there was paralysis of upward gaze, poor convergence and marked bilateral lid lag. The vision was OD 30/70 and OS 20/100. With pinhole it was OD 20/30 and OS 20/40. The exophthalmometer

reading with the setting at 118 mm. was OD 34 and OS 31. Irregular corneal opacities were present in both eyes.

Bilateral transantral orbital decompression was done on October 10, 1947. The infraorbital nerve was placed on a stretch when its canal was removed. It was noted that while the floor of the orbit was removed, some recession of the eye resulted, but greater recession occurred when the ethmoidal plate was removed.

Postoperatively, there developed filamentous keratitis. At one month the exophthalmometer readings were OD 28 mm. and OS 25 mm., and six months later the readings were OD 27 mm. and OS 26 mm. In 1953

Fig. 7-A. Incision of periosteum with knife.

the vision was OD 20/40-2 and OS 20/40-1, and with glasses OD 20/40-1 and OS 20/40-1.

The patient was seen frequently in the Endocrinic Clinic, was readmitted to Barnes Hospital February, 1953, and the thyrotoxicosis was treated with tapazole, lugols and radioactive iodine. An additional diagnosis of auricular fibrillation and pulmonary embolism was made. There has been no further progression in the exophthalmos and with the occasional upper respiratory infections orbital complications have not resulted. Some residual numbness of the cheek has been present.

Case 3. E.T., 44, w.m., was admitted to Barnes Hospital January 27, 1950, with a history of proptosis for one month.

Four and a half months previous to admission the patient developed

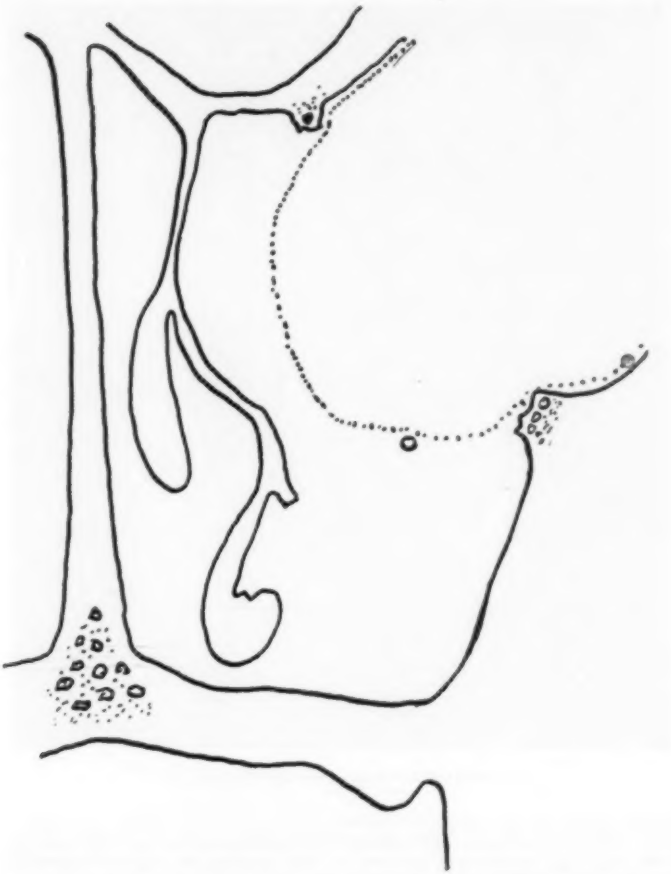

Fig. 7-B. Decompression of eye into ethmoid and maxillary sinuses.

nervousness, weakness, weight loss, palpitation, mild exophthalmos and a BMR of plus 8. In the past history, a partial thyroidectomy was done four years previously.

Examination revealed marked proptosis, injection of the conjunctival vessels and poor convergence. There was failure of the eyelids to approximate. The vision was OD 20/200 and OS 10/200. The BMR was 0. With the exophthalmometer setting at 104, the reading was OD 29 mm. and OS 30 mm.

Fig. 8-A. Case 1 pre-operative.

In order to compare the amount of decompression by the external route and the transantral method, it was decided to try both methods in the same patient. On January 31, 1950, an external frontal was done on the left with removal of the medial wall of the orbit and part of the floor. A transantral decompression of the eye was done on the right eye.

Immediately after surgery the vision was OD 20/200 and OS 20/200; however, there was much more apparent recession on the right and considerable postoperative lid edema and chemosis of the conjuntiva on the left. February 7, 1950, the exophthalmometer readings were OD 24 mm. and OS 24 mm. at 100 mm.

Over the past five years there has been no progression of the exophthalmos, and with the usual upper respiratory infections complications have not occurred.

Fig. 8-B. Case 1 post-operative (2 years).

Case 4. D.M., 40, w.f., with a history of progressive exophthalmos since 1944, first on the right followed by that on the left. The BMR was plus 15 in 1948.

In 1950 there developed the first of eight corneal ulcers on the right side. The thyroid gland was not particularly enlarged. The vision was OD 20/400 and OS 20/400, and with glasses was OD 20/25 and OS 20/15. The exophthalmometer reading was OD 30 mm. and OS 28 mm.

Bilateral orbital decompression was done April 6, 1953, with effective relief immediately. There has been no further orbital complications of any sort despite three or four colds per year.

Case 5. M.L., 63, w.f., was admitted to McMillan Hospital in March, 1956, with a history of exophthalmos of six months' duration. In 1928, for thyrotoxicosis, she underwent a thyroidectomy with no post-operative complications. During this six-month period before admission she developed a corneal ulcer. A diagnosis of thyrotropic exophthalmos was

Fig. 10-A. Case 5 pre-operative.

made, and the following findings were noted: OD vision 20/200 with corneal opacification. OS 20/50, marked edema of the lids and cornea, and bilateral external ophthalmoplegia. The Hertl exophthalmometer showed OD 22 mm. and OS 21 mm. at 96 mm. Wydase infiltration was done to the anterior chamber without any benefit.

On March 16, 1956, a right temporal orbital decompression was done without definite effect. On April 6, 1956, bilateral transantral orbital decompression was performed (see Figs. 10-A, 10-B). She had a stormy postoperative course requiring repeated tarsorrhaphy, inasmuch as orbital infection developed. Whereas immediate improvement was noted on the operating table, definite visual and objective recession was noted by May 4. An enucleation was done on the right eye because of panophthalmitis and rupture of the globe. When she was last seen in December, 1956, there was good vision in the left eye, practically no edema, and

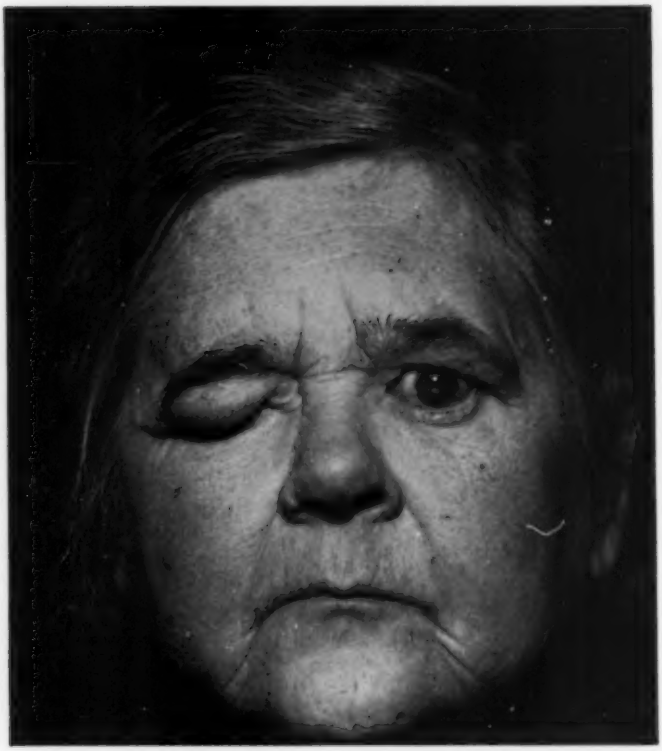

Fig. 10-B. Case 5 post-operative (7 months).

the ophthalmological service was scheduled to put an artificial eye in her right orbit.

Case 6. R.D., 33, c.f., had a subtotal thyroidectomy in 1950 and again in 1955 for thyrotoxicosis with development of progressive exophthalmos following the second operation. Irradiation to the pituitary and Wydase infiltration into the eye chamber was done with no improvement. The exophthalmos seemed to progress over the next several months. March 25, 1956, she was admitted to the eye service, where marked edema of the lids was noted, with injection of the conjunctiva. Vision was 20/20 in both eyes and the Hertl exophthalmometer showed OD 28 mm. and OS 29.5 mm. at 103 mm. The eyes were straight in the primary position. There was exophoria for distance and near of about 4-5°. There was limitation of action of the superior rectus with diplopia in that field of gaze, and she was unable to close her lids. Wydase in-

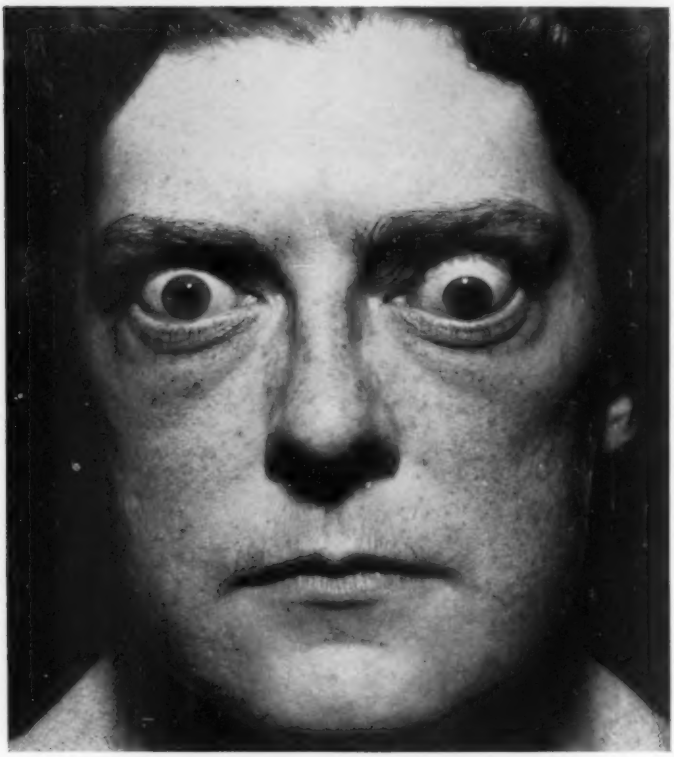

Fig. 11-A. Case 7 pre-operative.

filtration was again repeated followed by temporal orbital decompression without improvement.

August 30, 1956, a bilateral transantral decompression was done without complications. On December 11, the Hertl exophthalmometer was OD 26 mm. and OS 28 mm. with a setting of 103 mm. The recession was slight, but the edema and the injection of the conjunctiva disappeared promptly, and she was able to close her eyelids.

Case 7. C.S., 36, w.f., gave a history of progressive exophthalmos, diplopia and inability to close the eyes for about 17 months. Three months prior to the onset of the eye complaints, she had a thyroidectomy for thyrotoxicosis. In May, 1956, the eyes began to tear constantly. The conjunctiva and lids were chemotic. The venous system was engorged. The vision was OD 20/20 and OS 20/20. The Hertl exophthalmometer reading was OD 24.5 mm. and OS 25.5 mm. with the setting at 103 mm.

Fig. 11-B. Case 7 post-operative (2 months).

She was started on Triiodothyromine for one month without improvement. In June she developed a corneal ulcer. She had double vision with 18 previous degrees of hypertropia. A transantral decompression was performed November 9, 1956 (see Figs. 11-A, 11-B, 12-A and 12-B), with no post-operative complications. December 11, the Hertl exophthalmometer reading was OD 21 mm., and OS 21 mm., with the setting at 103 mm.

Case 8. L.C., 40, w.f., was admitted to the ophthalmological service with a history of swelling of the eye and lid for three months. Eight months previously, for typical symptoms of hyperthyroidism, she received 5.5 millicuries of I-131 with 76 per cent uptake on June 14th. She improved rapidly, but in September exophthalmos appeared suddenly. Thyroid extract was started. Weakness of the extra ocular muscles was soon replaced with paresis and chemosis of the lid and cornea.

Fig. 12-A. Pre-operative.

When small punctate corneal ulcers appeared in December, bilateral tarsorrhaphy was performed. The Hertl exophthalmometer reading was 24 mm. in both eyes set at 103 mm. December 29, 20 units of cortophin zinc was started.

On admission to McMillan Hospital January 7, 1957, there was further corneal ulceration. The lids failed to approximate even with tarsorrhaphy, and with not only loss of extra occular movement but also failure of the lid closing movement. January 11, 1957, bilateral transantral orbital decompression under endotracheal anesthesia with the use of hypotensive drugs was done. Dramatic recession was noted, and there was immediate recovery of the ability to close the lids. Two weeks after surgery the tarsorrhaphy adhesion was released.

Fig. 12-B. Post-operative.

DISCUSSION.

Immediate and satisfactory recession of the eye by surgical decompression of the orbital contents into the maxillary and ethmoid sinuses can be readily accomplished for progressive malignant exophthalmos. Such emergency operations have been performed in seven patients with varying degrees of exophthalmos and loss of vision. Restoration of vision has been prompt and cosmetic improvement has been satisfactory without resorting to external facial incisions and with minimum discomfort to the patient.

In comparing the pre- and post-operative readings obtained by the exophthalmometer, it is significant that the average reduction of 4-7 would compare with the favorable cases cited by Naffziger.

In trying to evaluate the extent of removal of bony wall necessary to effect recession of the eye, little recession was noted when the floor of the orbit was removed, but it was somewhat more obvious when the ethmoidal wall was removed. When the periosteum was incised, however, there was dramatic recession.

Decompression of the floor and the medial wall of the orbit for malignant exophthalmos exposes a large surface area of the eye immediately adjacent to the large spaces of the maxillary and ethmoid sinuses. In effect, it combines the Hirsch and Sewall methods for decompression and does afford immediate and lasting relief. Progression of the disease is apparently arrested, restoration of serviceable vision, extraocular movement and ability to close the eyelids is effected promptly; in addition, the cosmetic result is satisfactory.

It is significant that in one instance where previously the roof and lateral wall of the orbit had been removed, arrest of the disease occurred only after the orbit was transantrally decompressed (Case 1). It is also noted that external approaches to the medial wall of the eye are more immediately traumatic. In the end, the amount of decompression appeared to be the same (Case 3). The lateral orbitotomy (Kronlein) procedure has failed in two instances.

The degree of orbital tension present in the severe forms of exophthalmos is correlated with the degree of recession obtained by the transantral decompression. It is not at all unusual of obtain 4-7° recession measured by the Hertl exophthalmometer in these forms. On the other hand, when there is slight increase of orbital tension, and consequently little visual disturbances present (Case 6), the amount of measurable decompression is slight, and cosmetic improvement is not greatly improved.

The advantages of the transantral method seem obvious. There is no external incision, and the procedure is tolerated under local anesthesia with minimum discomfort. The criticisms that infection about the eye is likely in the otolaryngologic approach are unwarranted. The large inferior meatus antrum window and wide removal of the medial and inferior bony walls of the orbit insure against orbital complication due to infections. In some instances, some residual numbness of the cheek may remain. Diplopia or other muscle imbalance following surgery did not occur in any instance.

CONCLUSION.

1. Transantral decompression of the medial and inferior plate of the orbit in malignant exophthalmos is simple, immediately effective, lasting, affects rapid return of visual loss and return of the use of the extraocular muscles and eyelids and is cosmetically satisfactory.

2. Infections about the orbit and diplopia do not occur following decompression of the eye into the maxillary or ethmoid sinuses.

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THE EFFECT OF HEARING AID USE UPON THE USER'S RESIDUAL HEARING.*

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SUMMARY.

The pure tone thresholds of a group of partially deafened adults were examined after varying periods of hearing aid use to determine whether the hearing aids had led to a deterioration of unaided hearing. No significant change in hearing could be demonstrated.

INTRODUCTION.

A preliminary investigation was made in 1953 to determine whether hearing aid use had a deleterious effect upon the user's unaided hearing. A larger scale investigation suggested at that time was not made; therefore, the results of the preliminary investigation are presented here in brief because they well may be of some value to those concerned with the welfare of the deaf.

The last 20 years have seen a rapid increase of noise production in many avenues of life, a change paralleled by an increased awareness of acoustic trauma and the urgency of eliminating or reducing it.

The possibility that hearing may be damaged through the continued use of a hearing aid is well recognized, its recognition being based upon thoretical considerations and upon the often repeated claims of patients that their unaided hearing has grown worse since they started to use hearing aids. These claims may be the result of illusion, stemming from acclimatization to easier listening, but the hearing aid user listens to an audio amplifier, the acustic output of which may rise to intensities likely to damage hearing. The con-

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Editor's Note: This manuscript received in The Laryngoscope Office and accepted for publication March 22, 1957.

ductively deafened user's middle ear will attenuate all sounds entering the ear and, if the aid is providing adequate compensation, the stimulus at the cochlea is unlikely to be more than that at the cochlea of the normal listener under similar but unaided conditions. The nerve deafened user will not obtain the adequate hearing compensation that the conductively deafened enjoy, and he will probably observe that the relatively poor compensation is not improved by increasing the gain of his aid. The nerve deafened will, for this reason, be unwilling to raise the gain of his hearing aid to such a level that even the occasional loud sound causes discomfort. The risks of damage to hearing appear to diminish when the problem is considered in this way, but the facts may belie the theory.

The acceptability of hearing aids has increased greatly in the last ten years until it seems that no further striking increase can be expected for a long time to come. Attention is now focusing again on the problems of desirable circuit design rather than upon size and running costs. If there is evidence that a hearing aid may damage a deaf ear, then the inclusion of some form of output limitation may lessen the risks of damage; if the evidence is to the contrary then the inclusion of output limitation becomes of less urgent concern, to be decided by other considerations.

The advent of the Government, or Medresco hearing aid, in England presented an excellent opportunity for studying the effects of hearing aid use. A large number of people obtained the Medresco aid, in most cases after pure tone threshold audiometery, and opportunities of following the course of these hearing aid users were afforded as they returned to distribution centers for supplies of batteries.

This report concerns the progress of 120 such users.

SELECTION OF SUBJECTS.

The hospital records of 1480 patients, to whom Medresco aids had been issued, were examined and preliminary selection criteria were applied thus:

1. Audiogram available showing air conduction hearing just before issue of the aid, and showing the presence of measurable hearing in each ear for at least the four test tone frequencies of 0.5, 1.0, 2.0 and 4.0 Kc/s.

2. Cross-conduction hearing unlikely to be occurring, and masking not used in the pre-issue pure tone tests.

3. No evidence of aural suppuration on or after date of issue of the aid.

4. No aural surgery after issue of the aid.

5. No hearing aid used before issue of Medresco.

An additional consideration borne in mind at this stage was that the subjects finally included in the survey should consist of both young and elderly users, and should contain some subjects who had had their aids for a long time, and some who had them for only a short time. Cases appearing to satisfy these criteria were circularized and invited to attend for re-examination and re-test, to have their hearing aids checked, and to receive supplies of batteries. The procedure followed as these users returned for review included:

1. Clinical history (including details of the use of the hearing aid).

2. Clinical examination of the ears.

3. Pure tone threshold audiometry (4 db. steps) by both air and bone conduction. (A single frontally applied receiver was used for the latter, and no masking was used in either air or bone conduction tests).

4. Repair of defective hearing aids.

The selection criteria applied earlier were then re-applied and were supplemented by one other, *viz.* insert type of receiver used throughout, and in only one ear.

DETAILS OF SUBJECTS AND OF HEARING AID EXPERIENCE.

Diagnoses.

Otosclerosis	38.3%
Healed suppurative otitis media	16.7

Meniere's Disease	10.0
Etiology uncertain	9.2
Presbycusis	7.5
Middle ear deafness plus acoustic trauma	6.7
Acoustic trauma	5.8
Congenital deafness	4.1
Post-meningitic deafness	1.7

(The preponderance of otosclerotics is off-set by the fact that many of them had been advised against fenestration on the grounds of poor cochlear reserve.)

Age Distribution (in years).

24 or less	9.5%
25 to 36	22.4
37 to 48	32.7
49 to 60	28.5
More than 60	6.9

Period of Hearing Aid Use (in months).

0 to 12	16.7%
13 to 24	0.0
25 to 36	19.2
37 to 48	32.5
49 to 60	25.8
61 to 72	5.8

Rate of Use (hours per day).

0 to 3	20.9%
4 to 6	19.1
7 to 9	12.2
10, or more	47.8

Sum Total of Use (in hours).

1,000 or less	19.8%
1,001 to 5,000	13.8
5,001 to 10,000	15.5
10,001 to 15,000	23.3
15,001 to 20,000	16.4
20,001 to 25,000	6.9
25,001 or more	4.3

EQUIPMENT.

The pure tone threshold measuring equipment was not a commercial audiometer but a unit comprising a pure tone oscillator and attenuator (2 db. step) built for the Medical Research Council under the direction of P. B. Denes, of University College, London. Standard Telephone and Cable receivers (Series 4026A) were used; after objective calibration of these receivers and the other equipment, a series of correction figures was available permitting conversion of attenuator dial readings to db. hearing loss relative to the normal threshold of hearing for pure tones.* The threshold tests were made in 4 db. steps.

RESULTS.

Discussion of Results.

The audiometric results obtained were examined in a number of different ways.

First, the statistical significance of changes in used-ear hearing shown by the whole group or selected portions of the group was examined. *Second*, the significance of the relation between *a*. changes in used-ear hearing, and *b*. changes in unused-ear hearing shown by the whole or selected portions of the group was examined.

The former method of examination of results implies acceptance, in part, of the accuracy of calibration of audiometers used as much as seven years before the author's tests were made. The second method implies acceptance only of the equality of accuracy on any subject's two ears; in other words, it was assumed that, if they had been present in the earlier tests, inaccuracies of calibration would have been repeated in testing each of a subject's two ears and would cancel out if the relation between the hearing, in used and unused ears, was studied rather than the absolute figures of hearing loss in the used ear. Unfortunately a change in this relation, during a period of hearing aid use, can be interpreted as an

*Dadson, R. S., and King, J. H.: A Determination of the Normal Threshold of Hearing and its Relation to the Standardization of Audiometers. (1952) Jour. Laryngol. and Otol., 66:366-378.

improvement of one ear, *or* as a deterioration of the other ear; but the demonstration of a *consistent* change would have served the purposes of this survey.

The "selected portions of the group" to which reference is made in the preceding paragraph included:

1. Subjects who had used their aids daily for more than three years.

2. Subjects who had used their aids more than eight hours per day for more than two years.

3. Subjects who had used their aids for more than 10,000 hours, irrespective of rate of use.

4. Subjects who had used their aids for more than eight hours per day for more than four years.

5. Subjects with better than the average bone conduction hearing.

6. Subjects with poorer than the average bone conduction hearing.

Two figures representing the "hearing" of an ear, referred to in the preceding two paragraphs, were used in each of the analyses. The first was the average of losses shown at the six octave frequencies 0.25 through 8 Kc/s (0.25 through 4 Kc/s for bone conduction). The second was the loss shown at 4 Kc/s.

Details of Results.

The findings of this survey are amply expressed by the statement that the changes in hearing observed after use of a hearing aid always failed to achieve significance at the 5 per cent level and may, therefore, be regarded as of no clinical significance.

One other observation of interest remains to be reported. It is that, in each of the appropriate analyses carried out, the young and the elderly long term and high rate users showed a tendency towards an improvement in used-ear hearing after a period of hearing aid use, a change which always

failed to reach a significant level. No such tendency was to be found in the short time or low rate hearing aid users.

DISCUSSION.

It is necessary at this point to reiterate the observation made earlier that, in those analyses where a change in the relation between the hearing losses of a used and an unused ear occurs during a period of hearing aid use, the change can be interpreted as an improvement of one ear or as a deterioration of the other. The use, in describing the test results, of the all-embracing phrase "showed a tendency towards an improvement in used-ear hearing," is reasonably justified by the observation that the tendency was consistently observed in those analyses using only absolute hearing loss figures while, in those same analyses, the unused ears showed no tendency to change. The alternative interpretation would be that one method of analysis revealed a tendency for used-ear hearing to improve, while another method of analysis revealed a tendency for unused hearing to deteriorate.

The cases included in the final 120 were highly selected, both intentionally and possibly unintentionally. If there are subjects whose hearing truly deteriorates after using a hearing aid they may have excluded themselves from this series by declining the invitation to have a hearing check. On the other hand, one of the services open to the people invited to attend was that of investigation and possible solution of their particular hearing and hearing aid problems. It is, therefore, just as reasonable to suggest that the people whose hearing was deteriorating would be the first to accept the offer. In fact, many letters were received from patients who declined to come for tests on the grounds that they were managing satisfactorily with their aids, had no problems, and, therefore, were not justified in losing time away from their work. None declined the offer in writing on the grounds that the hearing aid was useless or a menace to residual hearing.

It would have been of great interest to examine changes in discrimination following hearing aid use. Unfortunately

routine speech audiometry was in its infancy when many of these subjects first received their aids, and the early demands for the Medresco aid were enormous; consequently only a few of the series had received speech tests, a number too small to permit any conclusions.

ACKNOWLEDGMENT.

This investigation was designed and completed at the Wernher Research Unit of the Medical Research Council of England, under the direction of Terrace Cawthorne, F.R.C.S.

UNIVERSITY OF ILLINOIS OTOLARYNGOLOGIC ASSEMBLY.

The Department of Otolaryngology, University of Illinois College of Medicine, announces its Annual Assembly in Otolaryngology from September 30 to October 6, 1957. The Assembly will consist of an intensive series of lectures and panels concerning advancements in otolaryngology, and evening sessions devoted to surgical anatomy of the head and neck and histopathology of the ear, nose and throat.

Interested physicians should write direct to the Department of Otolaryngology, 1853 West Polk Street, Chicago 12, Ill.

PRACTICAL ASPECTS OF THE CRICOTHYROID SPACE*

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and
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Acute laryngeal obstruction requiring immediate measures is generally treated by endotracheal intubation or tracheotomy. In the hands of the experienced operator this is quite satisfactory; however, in certain situations the lack of proper instrumentarium or the inexperience of the responsible physician precludes the employment of either of these methods. The increasing number of civilian accidents, plus the threat of nuclear weapons attack, has greatly aroused doctors to emphasize the importance of relief of respiratory obstruction.[1,2] This latter threat has demanded that personnel, totally unacquainted with the usual methods of treatment, may be responsible for this emergency.

The cricothyroid space is hereby recommended as an ideal area for performing an emergency laryngotomy (intercricothyrotomy). Intercricothyrotomy is technically simple, relatively free of serious complications, and is defined as opening the space between the anterior inferior border of the thyroid cartilage and the anterior superior border of the cricoid cartilage (see Figs. 1, 3-A). This region is the most accessible point of the respiratory tree inferior to the glottis.

SURGICAL ANATOMY.

Externally, the cricothyroid space is usually readily identifiable. It is the concavity which lies between the convex borders of the inferior portion of the thyroid cartilage and the superior border of the cricoid cartilage (see Figs. 1, 3-A,

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Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication Dec. 14, 1956.

3-B). In searching for this area in the neck, the palpating finger should initially identify the thyroid prominence (Adam's apple). Then proceeding caudad in the midline of the neck, the first depression encountered is the cricothyroid space. This is the area through which intercricothyrotomy is performed.

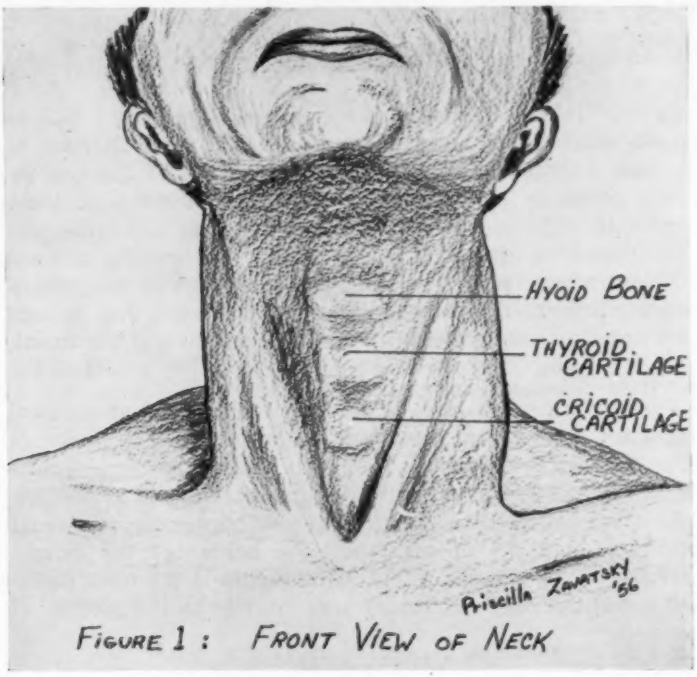


FIGURE 1: FRONT VIEW OF NECK

Although the larynx usually lies in the midline, one must be cautioned that occasionally this structure may be deviated (see Fig. 2). In obesity or large neck tumefactions about this area, it may be necessary to incise the skin and subcutaneous tissue before being able to identify accurately this space. In any event, it is imperative that this region be identified prior to any surgical manipulation.

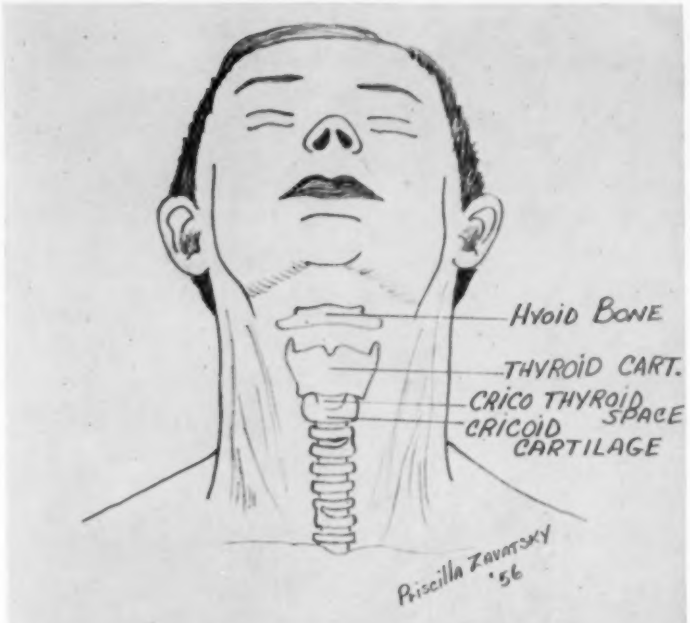


FIGURE 2 : FRONT VIEW OF NECK SHOWING LARYNX

The cricothyroid space is roughly a trapezoid with a cross-sectional area of approximately 2.9 square cm., and is adequate for performing an intercricothyrotomy. In order to further delineate this area, 51 adult larynges were examined, and the following measurements, as specified, were recorded (see Figs. 3-A, 3-B, 4) :

1. The contiguous distance between the anterior inferior border of the thyroid cartilage and the anterior superior border of the cricoid cartilage, represented as "A", ranged from 0.5 cm. to 1.2 cm., with the average being 0.9 cm.

2. The workable width of the cricothyroid space, represented by "B", varied from 2.7 cm. to 3.2 cm., with the mean being 3 cm.

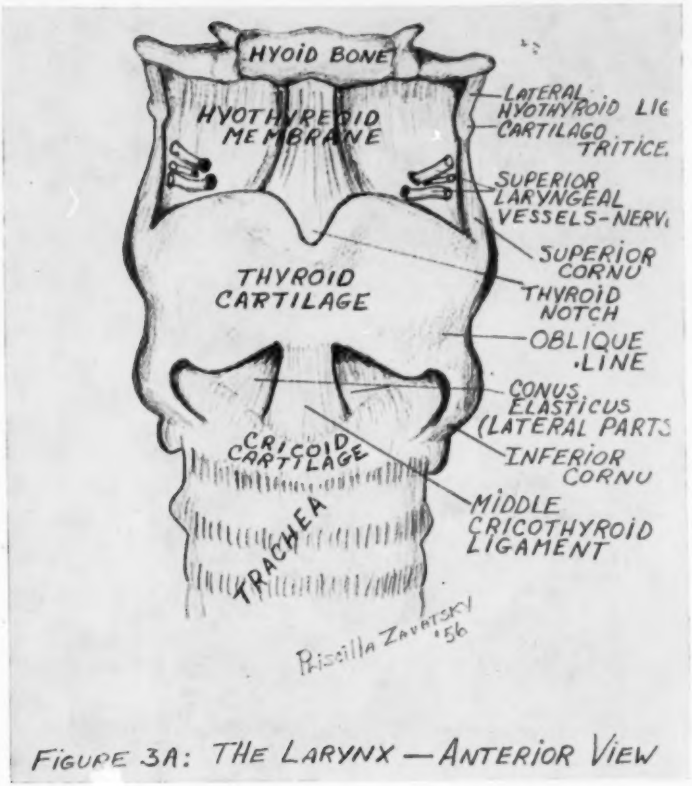


FIGURE 3A: THE LARYNX — ANTERIOR VIEW

3. The minimal workable vertical distance measured at the lateral aspects of the cricothyroid space, represented by "C", varied from 0.2 cm. to 0.6 cm., with the average being 0.3 cm.

4. The distance between the true cords and the mid-horizontal plane of the cricothyroid space, represented by "D", averaged 1.3 cm.

5. The vertical distance of the cricoid arch was 0.7 cm., while the posterior plate measured 2.5 cm. vertically.

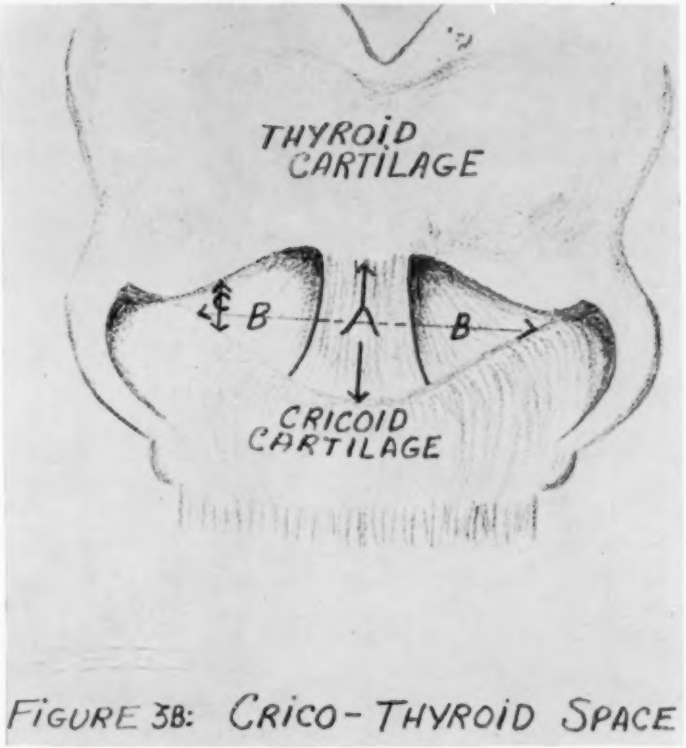


FIGURE 38: CRICO-THYROID SPACE

In performing an intercricothyrotomy, the structures encountered from without inward are: The skin, subcutaneous tissue, cervical fascia, medial aspects of the cricothyroid muscles, median cricothyroid ligament, medial portion of the lateral cricothyroid ligaments, and the endolaryngeal mucosa (see Figs. 5-A, B). The only major blood vessel is the cricothyroid artery. The veins are usually small, and there are no nerves of importance in this vicinity.

INDICATIONS.

Intercricothyrotomy is indicated only in those instances of

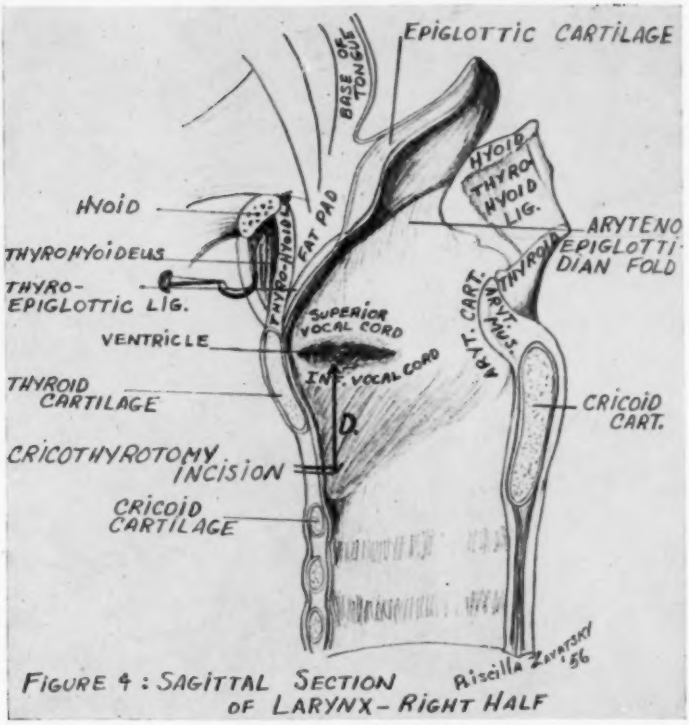


FIGURE 4: SAGITTAL SECTION OF LARYNX - RIGHT HALF

laryngeal obstruction in which an absolute emergency exists, or when a delay would result in a fatality. Where the equipment is available and the experience of the operator permits, bronchoscopy, endotracheal intubation, or classical tracheotomy are the procedures of choice; however, these measures are not without significant danger. Endotracheal intubation, whether using an endotracheal tube or a bronchoscope, requires definite skill. This is particularly manifested in attempting intubation in a patient with a pathologically obstructed larynx who has already suffered considerable vital respiratory depression. A single unsuccessful manipulation here may increase the obstruction, and a critical situation may be altered to a hopeless catastrophe.

Classical tracheotomy, when performed under the proper circumstances, may be a safe procedure; but when faced with the urgency of impending asphyxia, the relative inaccessibility of the lower tracheal rings, and the anatomical vascular barriers of the region, a genuine surgical challenge is presented.

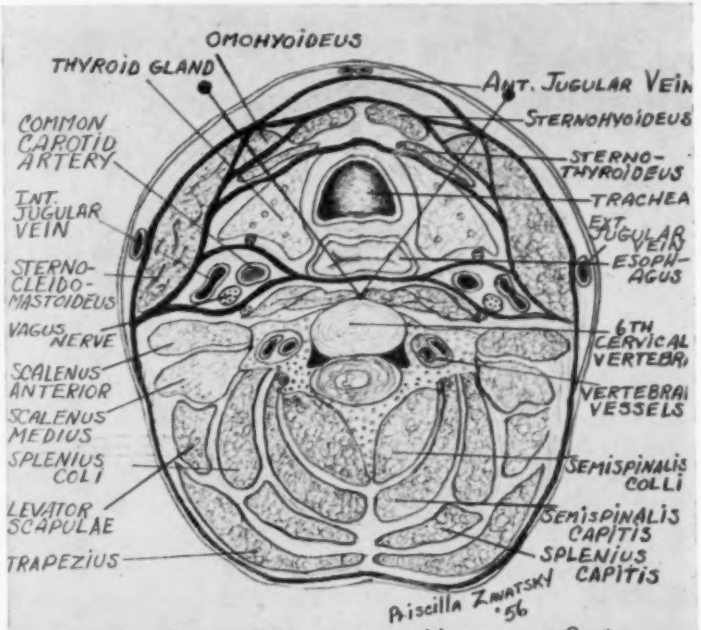


FIGURE 5A: CROSS SECTION OF NECK AT C-6

TECHNIQUE.

In performing an intercricothyrotomy, any sharp instrument can be used when necessary. Where available, a surgical scalpel is most satisfactory, and was employed in the two case reports which follow. Allbritten[2] has suggested that a knife can be passed transversely into the cricothyroid space,

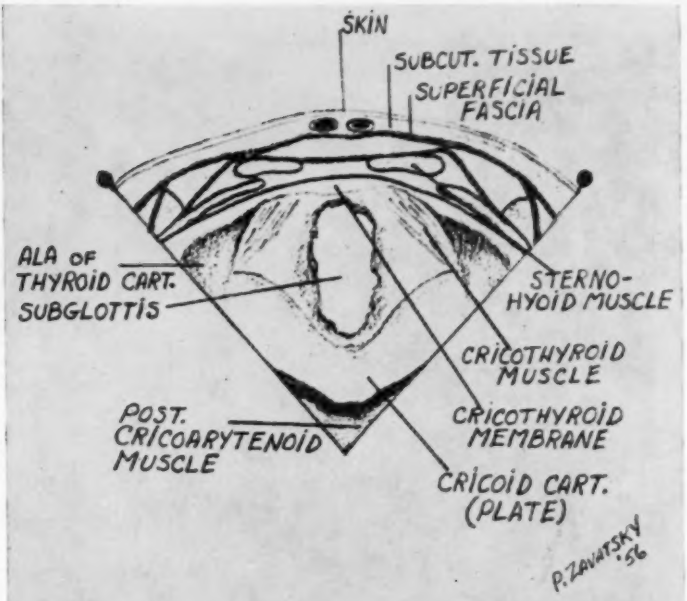
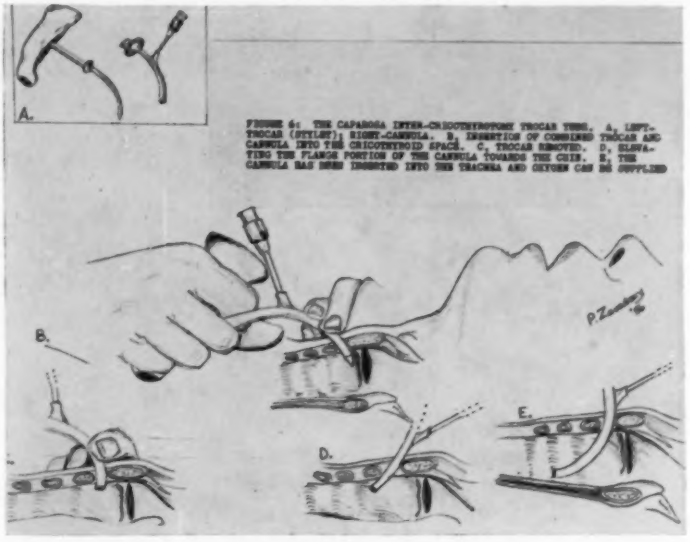


FIGURE 5B: TRANSVERSE SECTION THROUGH CRICOTHYROID SPACE

and the handle of the knife or other suitable flat object; *e.g.*, a screwdriver, could be turned vertically in the incision, thusly spreading the thyroid and cricoid cartilages to provide a gaping airway. Georgiade[3] relates that in extreme emergencies, the use of 14-16 gauge needle inserted into the cricothyroid space may be used effectively to maintain an airway until a lower tracheotomy can be performed. This is of great value, especially if oxygen is available.

Jacoby[4] suggests that when after respiratory obstruction, all commonly applied methods of providing a clear airway have not been successful, or unable to be accomplished, the percutaneous insertion of an oxygen-carrying needle into the tracheal lumen may prevent a respiratory death.

Regarding the use of such needles, care must be taken to avoid the inadvertent withdrawal of these airways. Perhaps the use of a curved needle may eliminate or reduce this possibility; furthermore, several trocar penetrating tubes have been devised to complete an intercricothyrotomy. Wilson[5], Delaney[6] and Caparosa[7] have designed such devices to com-



plete the procedure of intercricothyrotomy. Only the latter two have designed such devices to complete the procedure in one sweep.

The Caparosa intercricothyrotomy tube (see Figs. 6, 7) is comprised of an outer flattened curved tube and a well-fitting handled inner-stylet, the end of which protrudes 0.8 cm. in a double edge cutting fashion. The cross-sectional area measures 28 sq. mm., which is equivalent to the cross-sectional area of a standard No. 5 Jackson tracheotomy tube. The instrument is made of stainless steel and can be autoclaved. Unlike the Caparosa trocar tube, which can perform the in-

tercricothyrotomy in one sweep, Wilson's flattened tube has a blunt forward end which is inserted only after an initial incision has been completed with some other sharp instrument.

In performing the intercricothyrotomy, the patient is placed in the supine position with the head partially extended.

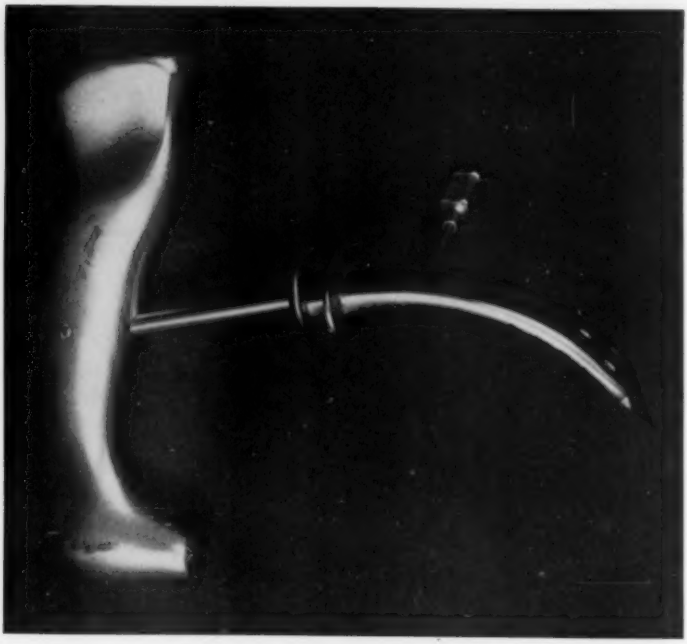


Fig. 7-A. The Caparosa Trocar Tube.

Forcible extension of the head may induce sudden apnea; extension should not be carried out until all preparations for the actual incision have been completed. The skin overlying the cricothyroid space is marked with the left index fingernail as the larynx is fixed between the left middle finger and the thumb. The left hypothenar eminence lies just in-

ferior to the patient's chin while the operator is standing to the right of the patient. If a scalpel is to be used, a transverse incision of approximately 1.5 cm. in length is made over the previously marked area. This incision may be continued bluntly or sharply through the cricothyroid membrane and endolaryngeal mucosa into the subglottis. If the former

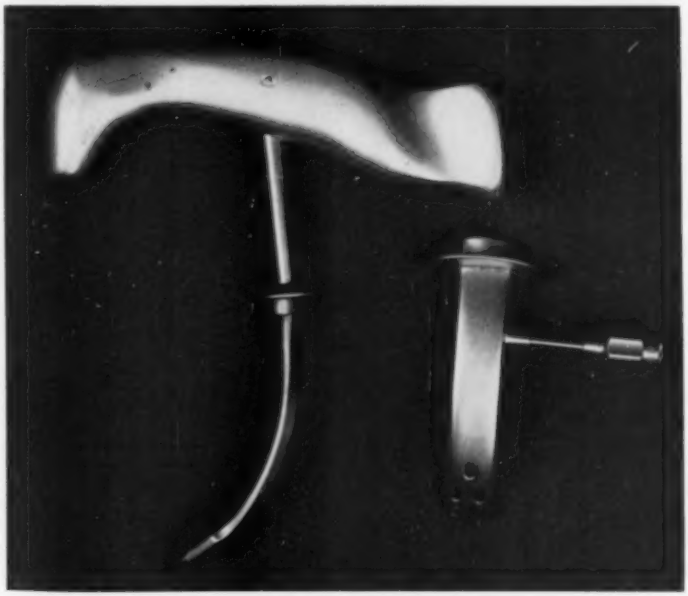


Fig. 7-B. The Caparosa Trocar Tube.

is carried out, care must be taken to avoid the establishment of a false passage. A sudden gush of air will assure the operator that the endolaryngeal space has been entered. The wound patency may then be maintained by using the reverse end of the scalpel or any other suitable instrument.

In using the Caparosa trocar tube, the cricothyroid space is outlined as above. The tube is held in the right hand in such a manner that the palm envelops the handle, and the

tube extends between the index and middle fingers. The oxygen inlet will not be enclosed and thus not interfere with the free motion of the hand. The right hand is held with the hypothenar eminence over the manubrium while the operator is to the right of the patient. The instrument is then directed into the cricothyroid space. The end of the outer tube is held between the thumb and index and middle fingers of the left hand. Pressure is then applied with the right hand in a gentle but firm, steady manner (see Fig. 6-B). A definite "give" will be felt as the tube passes through the cricothyroid membrane. The stylet is then immediately removed (see Fig. 6-C), whereupon, a sudden gush of air will assure the operator that the endolaryngeal space has been entered. The flange of the tube is then elevated toward the chin (see Fig. 6-D), and the tube is then carefully introduced further into the trachea. It is secured in place, and oxygen attached if available (see Fig. 6-D).

The cricothyroid area affords an adequate margin of safety. Care should be taken, however, to avoid trauma to the cricoid arch anteriorly. The broad posterior plate of the cricoid (some five times the vertical distance of the arch) offers a solid barrier of protection to the posterior structures and esophagus.

A classical tracheotomy should be performed as soon as possible following intercricothyrotomy. Stenosis will be avoided if the space is permitted to close within eight to ten hours. Of interest, however, Wilson[5] has suggested that a tube may remain in place for as long as 48 hours. No such duration has been mentioned in the American literature. Wilson has also recommended this route for insertion of endotracheal anesthesia tubes during surgical procedures in which the usual method of introduction is contraindicated. Frequently, however, transtracheal medications are instilled through the cricothyroid space. Familiarity with this procedure will greatly facilitate the performance of an intercricothyrotomy in a real emergency.

COMPLICATIONS.

The complications, which are not greater than those of

tracheotomy, are relatively few and can be avoided by proper technique. Possible complications are: bleeding, false passage, stenosis, emphysema and infection. Bleeding occurs usually as a result of injury to the cricothyroid artery or its branches. If the bleeding cannot be clamped immediately, the hemorrhage can be controlled by widening the incision and grasping the bleeding points laterally. This situation occurred in the second case reported.

A false passage may occur if the incision is incomplete or made improperly. This can be avoided by completing the incision prior to inserting any instrument in order to maintain the patent airway. If the Caparosa trocar tube is used, no prior incision is necessary. A sudden gush of air will assure the operator of proper passage.

Laryngeal stenosis will occur if the endolaryngeal structures are mutilated, if the cricoid cartilage is severed, or if a canula is allowed to remain in place for any prolonged duration. The use of a flattened tube will also lessen the possibility of this complication. In the first case report, a No. 5 Jackson tracheotomy canula was in place for six hours with no developing stenosis. Every effort, however, should be made to perform a classical tracheotomy as soon as possible.

Emphysema may follow, but this may be avoided if there is minimal dissection of the adjacent cervical tissue, and if the incision, if necessary, is not tightly sutured.[5]

Mediastinal infection is a most serious complication. The protective barrier of the broad posterior cricoid plate will serve to prevent any penetration of the esophageal or deeper structures, except where excessive forcefulness has been utilized.

CASE REPORTS.

Case 1. A 22-year-old white male, comatose, was admitted to the U. S. Army Hospital in Neurenberg, Germany, following an automobile accident. A diagnosis of multiple fractured ribs, fractured femur and intercranial injury of undetermined extent was made. Appropriate orthopedic treatment was given. The patient's condition remained unchanged until 2:00 A.M. of the next day, when it was observed that respirations suddenly became labored with cyanosis developing. At 2:15 A.M., an immediate intercricothyrotomy was performed employing

a No. 15 bladed scalpel. The patency of the incision of the cricothyroid space was maintained by the insertion of the handle and then twisting it in a vertical position. Within approximately ten minutes, a No. 5 Jackson tracheotomy tube was then introduced into the above area into the trachea. Six hours later a classical tracheotomy was performed at which time the cricothyrotomy incision was closed. The patient responded satisfactorily, and his recovery was uneventful with no evidence of stenosis. Chest X-rays revealed the respiratory embarrassment to be due to laryngo-pharyngeal emphysema, secondary to a ruptured bronchus.

Case 2. A 37-year-old negress was admitted to the U. S. Army Hospital, Neurenberg, Germany, for severe, generalized headaches of 36 hours' duration. An initial impression of encephalitis was made. Several hours later the patient lapsed into a coma. On the second hospital day, the patient developed sudden dyspnea, frothing at the mouth, gurgling secretions and cyanosis. An intercricothyrotomy was done employing a No. 11 bladed scalpel, and the vertically inserted handle served to maintain the wound patency. Immediately the dyspnea was relieved. Moderate bleeding that occurred necessitated extending the incision laterally and ligating the bleeding vessel. A classical tracheotomy was performed shortly thereafter, but the patient expired five days later. Post-mortem examination revealed tuberculosis meningitis and encephalitis. Endolaryngeally, there was beginning healing of the original incision in the cricothyroid membrane. There was no evidence of beginning stenosis or ulcerations noted.

SUMMARY.

Intercricothyrotomy is suggested as a technically simple, and relatively safe procedure, by which laryngeal obstruction can be relieved when the classical methods of tracheotomy or endotracheal intubation are not feasible. The surgical anatomy, indications, technique, contraindications and complications are described. A cutting trocar instrument is also illustrated to facilitate this procedure. Two case reports are also presented.

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SEVENTH INTERNATIONAL CANCER CONGRESS—LONDON, ENGLAND.

The Seventh International Cancer Congress will be held in London, England, July 6-12, 1958, under the Presidency of Sir Stanford Cade. Congress headquarters will be The Royal Festival Hall. This Congress is sponsored by the International Union Against Cancer.

There will be two main sessions of the Congress: A. Experimental; B. Clinical and Cancer Control. Special emphasis ill be placed on hormones and cancer, chemotherapy, carcinogenesis and cancer of the lung.

Papers will be considered only if submitted with an accompanying abstract (not over 200 words) before October, 1957, and if dealing with new and unpublished work.

The registration fee for the Congress will be £10 (ten pounds) or $30, and the latest date for registration without late fee will be January 1, 1958.

Registration forms and a preliminary program will be available early in 1957 on application to The Secretary General, Seventh International Cancer Congress, 45 Lincoln's Inn Fields, London, W. C. 2, England.

TUMORS OF THE NASAL CAVITY.*†

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Tumors of the nasal cavity are neoplasms which arise from those tissues which constitute it, and secondarily involve the neighboring structures or spaces. They may be small benign growths or invasive malignant tumors which present problems of management. Many, however, may be extensive benign growths or invasive malignant tumors which present problems both in diagnosis and management. There have been numerous reports in the otolaryngologic literature of the pathology, diagnosis, and treatment of tumors of the paranasal sinuses; however, tumors of the nasal cavity *per se* have received less attention. Since their management initially must be adequate and thorough, it is our objective to focus attention upon them.

Many of the problems with which we are concerned are not in themselves startlingly new. We have been observing an appreciable number of nasal tumors having a gross fleshy, papillomatous appearance, which on microscopic study have been considered by some to be inverting papilloma.

Ormerod[1] considers most of these to be a form of cylindrical cell carcinoma, even though in their early stages of development they do not show the classical characteristics of malignancy. In 1908, Jonathan Wright[2] presented a paper entitled "Persistently Recurring Papillomata of the Nasal Chambers, with Some Remarks on the Differential Diagnosis of Epithelial Proliferation," in which he described several patients

*Read at the meeting of the Middle Section of the American Laryngological, Rhinological and Otological Society, Inc., Cleveland, O., Jan. 9, 1957.

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Editor's Note: This manuscript received in The Laryngoscope Office and accepted for publication Jan. 28, 1957.

exhibiting the same problems of recurrence which face us today.

Carcinoma within the nasal cavity was reported as early as 1858[3] with both clinical and histologic diagnosis. Ringertz[4] in 1938 reviewed the pathology of malignant tumors arising in the nasal and paranasal cavities, and maxilla, with greatest emphasis on those arising in the paranasal sinuses. New[5] reviewed the treatment of a large series of cases of malignant

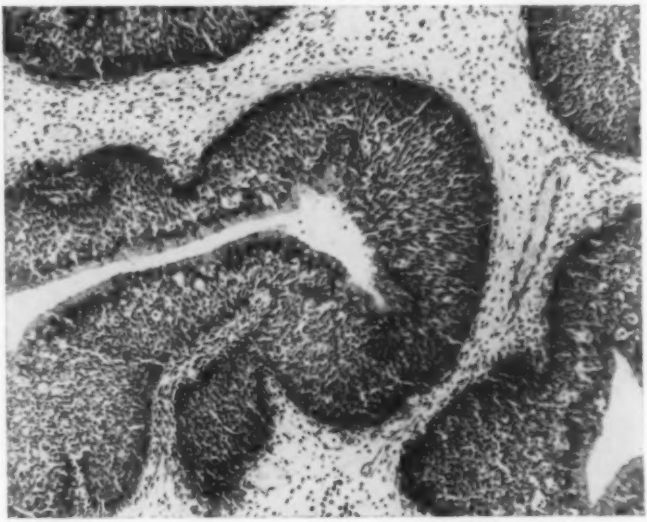

Fig. 1. Epithelial changes in inverting papilloma of the nasal mucosa.

tumors of the antrum of Highmore. Ohngren[6] reported the findings and treatment in 187 cases of malignant tumors of the maxillo-ethmoidal region. Willie[7] reported on 220 cases of malignant tumors of the nose and the accessory sinuses, followed from 1932 to 1944, most of which involved the paranasal sinuses. Schuknecht[8] in 1951 discussed the surgical management of carcinoma of the paranasal sinuses. Numerous other reports of smaller numbers of cases have focused attention to the special problems of diagnosis and manage-

ment which characterize malignancies of the paranasal sinuses.

Tumors of the nasal cavity, on the other hand, in our experience frequently present unusual problems of diagnosis and treatment. Signs and symptoms of tumors of the nasal cavity need not be reviewed in detail, except to mention that the outstanding presenting complaints are nasal obstruction, discharge, nasal bleeding and facial swelling or deformity.

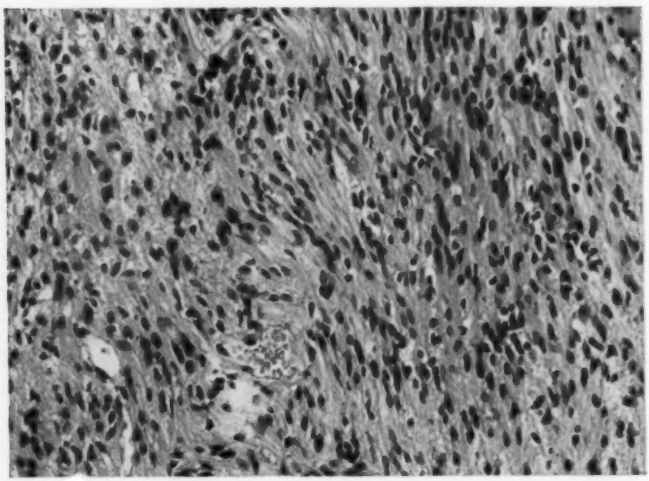

Fig. 2. Fibrosarcoma of the nasal cavity showing marked cellularity in a high power view.

Early, obstruction may be of a mild degree, but is unilateral and persistent. Bleeding, likewise, is usually unilateral, and may be so scant that it only streaks the mucus, or be productive of such massive hemorrhage that control is made most difficult. It is of importance to recognize that bleeding may be more severe in some types of benign neoplasms than in those which are malignant and ulcerated.

Polypoid changes in the mucosa of the nasal cavity are a common occurrence in the presence of numerous forms of

neoplasms of that region. The formation of large polypoid masses may be an actual part of the histologic change of the tumor, or it may be associated with the increasing pressure within the nasal cavity. This latter development of large nasal polyps may mask the underlying neoplastic changes both grossly and on repeated histologic study, so that great care must be taken to evaluate the condition thoroughly in

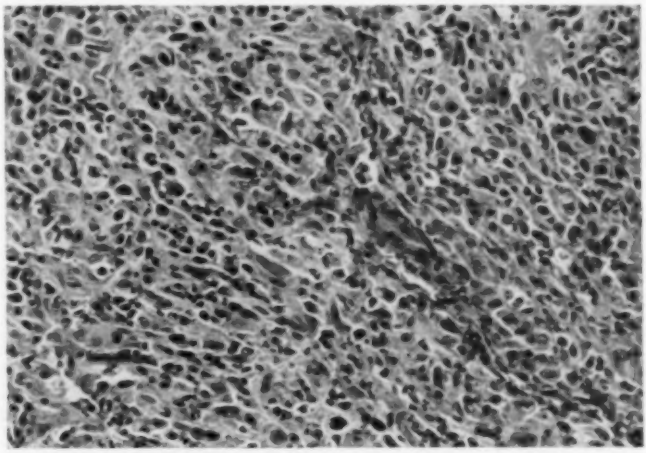

Fig. 3. Malignant melanoma.

order that it not be considered "just nasal polyps," thereby losing valuable time for successful intervention. There is a need in such cases for adequate biopsy.

All tissues removed from the nose must be examined microscopically, even though they have the gross appearance of benign polypoid tissue. Rapid recurrence of so-called "polypoid tissue," after removal which was considered thorough, is in itself a warning sign that an underlying malignant tumor may be present. In instances where there is doubt or where previous biopsy or biopsies have revealed only polypoid change, a more adequate biopsy under hospital conditions may be advisable in order to obtain sufficient tissue and to

be in a better position to manage severe hemorrhage which may ensue. Experience indicates that biopsy in the office may prove inadequate because of the superficial bits of tissue which result from the concern for the possibility of severe bleeding, or technical difficulties in trying to snare tissue from a mass which is too large and even too firm. Repeated biopsies, stained smears, or aspiration biopsy may be necessary and should be carried out whenever suspicion of

Fig. 4. Outline of Fergusson incision for external approach to tumors of the nasal cavity.

the histological character of the tumor is not confirmed by the original biopsy, especially when an obstructive mass persists. It is necessary that we point out that whenever tissues are removed bilaterally, specimen material from each side should be bottled separately and labeled accordingly.

Many growths arising in the nasal cavity are benign tumors. These include chondroma, fibroma, mixed tumors, angiofibroma, inverting papilloma, neurofibroma, hemangio-

ma, osteoma and others, which originate from the representative tissues of that area. These may show no demonstrable histologic features of malignancy.

Others are quite clearly malignant tumors which histologically and clinically demonstrate the features of malignancy such as anaplasia, infiltration, and destruction, rapid and uncontrolled growth, variability in size, shape and staining

Fig. 5. Malignant melanoma developing in the nasal cavity. A.—Huge deforming tumor mass involving the entire nose. B.—Showing response to X-ray therapy. The tumor later recurred but palliation with irradiation treatment was very satisfactory.

properties of the cells, and metastases. We have observed various types of carcinoma in the nasal cavity, including squamous cell carcinoma, transitional or cylindrical cell carcinoma, adenocarcinoma, melanocarcinoma, and ameloblastoma. The malignant connective tissue tumors which may arise in this area include fibrosarcoma, chondrosarcoma, osteogenic sarcoma, plasmacytoma, and the lymphoblastomas.

In addition, there are certain tumors of the nasal cavity which by their very location near vital areas and by their

progressive, expanding growth tendencies may be considered histologically benign but clinically malignant. Among these are the chondromas, salivary gland tumors, and inverting papillomas. Microscopic examination of such growths may evidence a benign histologic pattern with some orderliness of growth, but the clinical course may be a progres-

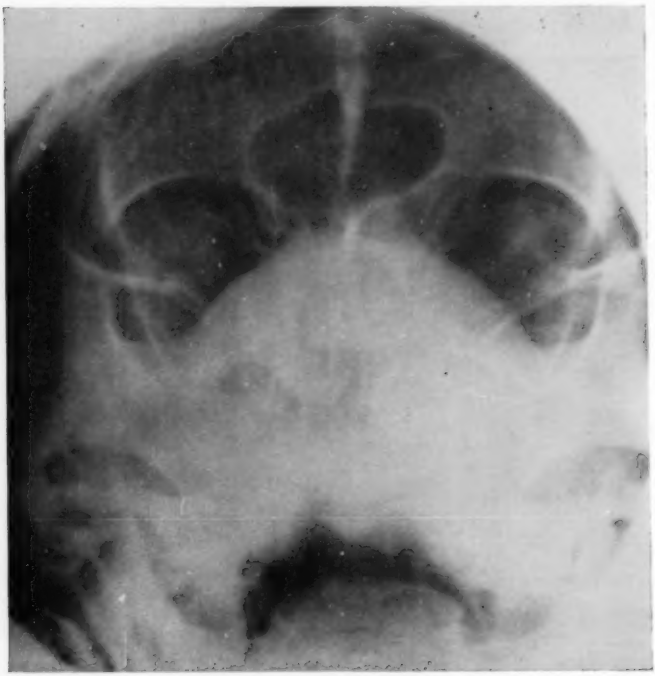

Fig. 6. X-ray view of huge malignant melanoma shown in Fig. 5.

sively destructive one with subsequent involvement of the surrounding nasal bones, nasal accessory sinuses, orbit, cribriform plate, and cranial cavity. It is obvious that treatment in such cases must be vigorous and thorough in order to eradicate the further extension of such a potentially expanding destructive tumor mass.

Fig. 7. Osteoma of right nasal cavity. Huge bony mass is shown filling the right side of the nose.

The diagnosis of tumors of the nasal cavities requires a careful evaluation of the history, thorough anterior and posterior rhinoscopy, multiple correctly positioned X-ray studies, and an adequate biopsy. The value of an X-ray assessment may be enhanced by laminagraphic studies which may reveal the site of origin of the neoplasm. Benign tumors which produce obstruction may demonstrate an opacity of the nasal fossa associated with accessory sinus clouding.

When structural displacement occurs there may be some thinning of bone and destruction by pressure necrosis. Malignant tumors may produce similar opacification but in addition there may be an obvious break in the continuity of the bone, often with markedly irregular destruction. Clouding in the sinus areas is not always to be regarded as evidence of extension of the tumor, since obstruction of the sinus ostium may lead to lack of aeration or to secondary infection producing an increased roentgenographic density.

Treatment of tumors of the nasal cavity varies considerably, depending upon the histological character and extent of the lesion. Therapy is essentially surgical, consisting of wide excision of the involved tissues as the chief means of attack. Irradiation therapy may be employed in conjunction with adequate surgical excision but is seldom used as the primary means of treatment.

Certain small-sized and many benign tumors which are not deeply situated in the nasal cavity may be removed by an intranasal surgical approach. In such instances there may be sufficient space for satisfactory exposure and hemostasis through the anterior naris. Small papillomas on the anterior septum, or hemangiomas in the anterior portion of the nasal cavity, at times can be satisfactorily removed in this manner under local or general anesthesia.

More extensive benign and malignant tumors demand more adequate exposure of the nasal cavity for complete removal. General anesthesia is preferred in such cases. Endotracheal anesthesia and oral intubation provide a clear airway and prevent aspiration of blood into the tracheobronchial passages. Inasmuch as the surgical approach frequently is made through and into a very vascular bed, careful preoperative medical and surgical preparation is essential. Blood in sufficient quantity should be at hand for administration in the operating room. Many surgeons prefer preliminary external carotid artery ligation on the same side immediately prior to surgery of the nasal area. We, however, are not in agreement as to the routine employment of ligation.

The chief objectives of major tumor surgery of the nasal

cavity are adequate exposure, satisfactory hemostasis, and thorough excision of the tumor. To accomplish these objectives, especially in the presence of malignancy, we feel that an external approach is essential. Exposure of the nasal cavity is best obtained either by lateral rhinotomy alone or by the Fergusson incision combined with lateral rhinotomy. The Fergusson incision consists of the arms placed at right angles to each other. The vertical arm is directed in the groove between the nose and the cheek, passing around the ala of the nose and under the naris on the same side, and then is completed by passing downward to split the upper lip. The second arm is directed horizontally, lying beneath the eye and joining the vertical portion near the inner canthus.

With the horizontal arm exposure of the region of the antrum, it, too, can be inspected for the presence of tumor. This incision was first described in 1845 by Sir William Fergusson for resection of the upper jaw, but it can be equally well applied to expose the nasal cavity for resection of tumors which demand removal of the lateral wall of the nose. Priest and Kucera[9] recently described the treatment of maxillary tumors through the Fergusson external approach. In some patients an approach to the nasal cavity can be made through a lateral rhinotomy incision without splitting the upper lip and also avoiding the horizontal incision beneath the eye. The Moure operation, as reported by Portmann,[10] utilizes this approach combined with bony resection of the margin of the pyriform aperture. Bordley and Longmire[11] have described a lateral rhinotomy incision for exploration of the nasal fossae and paranasal sinuses. We prefer the Fergusson incision often employed without the horizontal arm, after which resection of the bony margins of the pyriform aperture brings the entire nasal cavity into view.

The extent of the surgical resection after the exposure has been effected is in part dependent upon the findings within the nasal cavity. Extensive benign tumors may demand resection of the entire lateral nasal wall, including the turbinates together with a portion of the nasal bones and ascending process of the maxilla. Malignant tumors may

invade surrounding structures such as the ethmoid region, maxillary sinus, palate and orbit. In such patients, preoperative preparation must include discussion of the possibility of palatal resection with or without orbital exenteration. Occasionally, too, the need for sacrificing the overlying skin comes into consideration for future prosthesis or plastic repair. Cold knife dissection, bone gouges and biting forceps may be supplemented by coagulation techniques or electrosurgical dissection.

Tumors of the nasal septum may likewise be approached by the lateral rhinotomy incision. Recently Kuhn, Devine, and Remine[12] reported a case of multiple mixed tumors in which one of the tumors developed on the nasal septum and was resected after exposure by lateral rhinotomy. Frequently, in the treatment of malignant tumors, palatal resection may be advisable in order to provide a satisfactory means of inspecting the operative cavity, to observe it closely over a long period of time for the possibility of local recurrence and to facilitate immediate attack on the site while still amenable to treatment.

With the use of either the lateral rhinotomy or the Fergusson incision, postoperative care is usually not difficult. Healing of the wound occurs rapidly and most often without notable complications. Sterile petrolatum gauze packs may be left in the operative cavity from five to seven days and then conveniently removed. When the palate has been resected, a soft plastic sponge may be used as a temporary prosthesis to permit the patient to eat more readily and to speak clearly. Later, a permanent prosthesis is constructed in the form of a dental plate with an attached superstructure obturator for closing the palatal defect and fitting directly into the operative cavity.

Irradiation therapy is the primary treatment of choice in certain tumors of the nasal cavity, and is useful in conjunction with surgical excision in others. It is of value particularly in the treatment of angiofibroma. Such juvenile fibromas often originate in the region of the sphenoid bone extending to the nasopharynx and nasal cavity. External

irradiation, radium needles, or radon seeds have been employed, implanted directly into the tumor. Erich[13] reports that irradiation is the treatment of choice in such tumors. Some of these have persisted in spite of adequate irradiation. Untoward tissue response, to say nothing of the possible inhibiting effects of irradiation upon the growth and development of facial bones, requires consideration. There are certain cases of juvenile fibroma in which the tumor may be so extensive that attempted surgical excision is advisable.

Intracavitary or external irradiation following surgery of malignant tumors provides the best combination for the care of such growths.[14] Intracavitary radium needles or radon seeds may be placed accurately under direct vision to obtain the advantages of intensive therapy during the first period of treatment of the tumor.

SUMMARY AND CONCLUSIONS.

Benign and malignant tumors of the nasal cavity may present special problems of diagnosis and treatment in otolaryngologic practice.

Accurate diagnosis and adequate therapy is dependent upon evaluation of the history, thorough rhinoscopic examination, competent X-ray studies, and sufficient biopsy material. If necessary, repeated biopsies should be carried out.

Large masses of polypoid tissue in the nasal cavity may mask underlying malignant neoplastic change.

The treatment of tumors of the nasal cavity is essentially surgical, although irradiation therapy may be used in combination with surgical excision.

Adequate exposure is the most important prerequisite for careful, thorough removal of benign or malignant tumors.

Though an intranasal approach is sometimes satisfactory in the treatment of small tumors easily exposed anteriorly, an external approach by way of the Fergusson incision is imperative for large benign growths and malignant tumors.

The external exposure provides a wide field both of the nasal cavity and the surrounding structures. This is essential

in the treatment of malignant tumors of the nasal cavity because accurate preoperative evaluation of their extent often cannot be made.

Resection of the palate is frequently necessary to eradicate the tumor and to provide a satisfactory means of inspecting the entire operative cavity.

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HEMIPARALYSIS OF THE LARYNX. TREATMENT FOR LOSS OF VOICE.

HENRY M. GOODYEAR, M.D.,
and
STEPHEN P. HOGG, M.D.,
Cincinnati, Ohio.

When paralysis of one-half of the larynx occurs, usually the paralyzed cord assumes a midline or a semilateral position; however, when the lateral position is assumed the glottis is too wide for any approximation of the cords. Thus the patient is not able to speak aloud.

Various operations have been used to correct this condition. The common one was to resect a wing of the thyroid cartilage, or some part thereof.

Recently I treated a young woman, age 32, who had had a paralysis of the left half of the larynx following cardiac surgery. The lesion had been present for one year, and no sound of voice could be made even in strenuous attempts.

My associate, Dr. Stephen P. Hogg, suggested the use of cartilage, and that lead me to consider homogeneous cartilage which we obtained by resecting a long piece of cartilage from the upper border of the left thyroid wing. The strip was approximately 6 mm. in width and 17 mm. long. This was done under local anesthesia. A thyrotomy was done, and the left vocal cord was elevated and the cartilage inserted approximately the full length of the cord. In order to elevate the cord even more, a few small pieces of cartilage taken sagitally from the median line of the left wing, thus further narrowing the glottis, were also placed medially over the implanted cartilage. The wound was closed, and the patient left the hospital on the third day.

The patient was again seen 21 days later, at which time

Editor's Note: This manuscript received in The Laryngoscope Office and accepted for publication March 9, 1957.

she said that she had come back to be examined prior to resuming her work as a telephone operator. The voice was satisfactory and she was to return the following day to resume her work at a telephone exchange.

SUMMARY.

We have presented a procedure for transplanting cartilage as a practical means of restoring the voice where an extreme lateral position is assumed in a paralysis of one-half of the larynx. The superior border of a wing of the thyroid cartilage was used to obtain homogeneous cartilage for use in elevating the vocal cord.

556 Doctors' Building.

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